NEC

User's Manual

78K0R-Link It!

Demonstration Kit for 78K0R-L series

78K0R/KE3-L

Document No. U19818EE1V0UM00
Date Published June 2009
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Printed in Germany

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EEDT-ST-005-10

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Revision History

Date	Revision	Chapter	Description
10 -06- 2009	V1.10	---	*78K0-Link It!* First Release

Table of Contents

CHAPTER 1 INTRODUCTION 9

1.1 Package contents 9
1.2 Features 9
1.3 System requirements 11
1.3.1 Optional system requirements 11
1.4 Trademarks 11

CHAPTER 2 78K0R–*LINK IT*! SYSTEM CONFIGURATION 12

2.1 78K0R–Link It! board 12
2.1.1 IO-Link Mode 12
2.1.2 Standalone Mode 12
2.2 Host computer 13
2.3 Power supply via USB interface 13

CHAPTER 3 78K0R–LINK IT! COMPONENTS 14

3.1 Power Supply Selector JP1 14
3.2 Discrete Voltage rail selector, JP2 16
3.3 I/O port voltage control, JP3 16
3.4 VDD Transceiver selector , JP4 16
3.5 M12 Connector, M1 16
3.6 USB interface connector, USB1 17
3.7 RESET button, SW1 17
3.8 (INTP0) Switch, SW2 17
3.9 (INTP4) Switch, SW3 17
3.10 Navigation switch, SW4 18
3.11 Configuration switch, SW5 18
3.11.1 Standalone / debug mode selection, SW5/bit1 19
3.11.2 On-Board debug function via USB selection, SW5/bit2 – bit3 – bit9 – bit10 19
3.11.3 UART mode selection, SW5/bit4-bit5 20
3.11.4 Display Driver control, SW5/bit6-bit7 20
3.11.5 AVREF control, SW5/bit8 20
3.12 Transceiver Configuration Switch SW6 21
3.12.1 DC-DC power down control, SW6/bit1 21
3.12.2 Transceiver bypass control, SW6/bit2-8 21
3.12.3 IO-Link Transceiver 22
3.13 Digital logic Power Supply switch, SW7 22
3.14 4-digit Numeric Display 23
3.15 Power LED, LED6 23
3.16 IO-Link Communication indicator, LED7 23
3.17 External main oscillator, Y1 23
3.18 Test pads, T1~T42 area and wrap field 24
3.19 MR (magneto-resistive) Sensor 25
3.20 Temperature sensor 25
3.21 PG-FP4 /PG-FP5 / QB-MINI2 connector, FP1 25

CHAPTER 4 FLASH PROGRAMMING 26

4.1 Flash Programming via MINICUBE2 (QB-MINI2) **26**
4.2 Flash Programming via TK-78K0R debugger **27**

CHAPTER 5 ON-CHIP DEBUGGING **28**
5.1 OCD via QB-MINI2 emulator **28**
5.2 OCD via TK-78K0R On-Board debug function **29**

CHAPTER 6 *780R – LINK IT!* INSTALLATION AND OPERATION **30**
6.1 Getting Started **30**
6.2 CD-ROM contents **30**

CHAPTER 7 HARDWARE INSTALLATION **31**
7.1 *78K0R–Link It!* Factory jumpers and switches Settings **31**

CHAPTER 8 SOFTWARE INSTALLATION **32**
8.1 IAR Systems Embedded Workbench for 78K installation **33**
8.2 IAR Systems visualSTATE Installation **33**
8.3 Device file package of 78K0R/Kx3-L for IAR Embedded Workbench installation **34**
8.4 WriteEZ4 installation **34**
8.5 *78K0R–Link It!* Sample program installation **34**
8.6 XML Device Description file installation **34**
8.7 USB Driver Installation **35**
8.7.1 Installation on Windows 2000 35
8.7.2 Installation on Windows XP 39
8.8 Confirmation of USB Driver Installation **42**

CHAPTER 9 FLASH PROGRAMMER WRITEEZ4 ..... **43**
9.1 Starting up the GUI Software **43**
9.2 Toolbar **44**
9.3 Menu Bar **44**
9.3.1 [File] menu 44
9.3.2 [Device] menu 46
9.3.3 [Setup] command 47
9.3.4 [View] menu 53
9.3.5 [Help] menu 54
9.4 Programmer Parameter Window **55**

CHAPTER 10 HOW TO USE WRITEEZ4 FLASH PROGRAMMING SOFTWARE **56**
10.1 Installing the WriteEZ4 GUI software **56**
10.2 Installing the driver **56**
10.3 Installing the parameter file **56**
10.4 Connecting and starting **57**
10.5 Start the WriteEZ4 GUI. **58**
10.6 Setting the programming environment **58**
10.7 Selecting a user program **60**
10.8 Autoprocedure (EPV)] command execution **61**
10.9 Terminating the GUI **61**
10.10 Restarting the GUI **61**
10.11 Erasing the flash memory (using the WriteEZ4) **62**

CHAPTER 11 IAR EMBEDDED WORKBENCH *78K0R–LINK IT!* SAMPLE PROJECT..... 63

11.1 Hardware setup..... 63

11.2 Sample Programs..... 64

11.3 Loading the Link It! sample project..... 65

CHAPTER 12 IO-LINK TEMPERATURE SENSOR SAMPLE..... 70

12.1 Demo Features..... 70

12.1.1 Min/Max Temperature display..... 71

12.1.2 Temperature thresholds setting..... 71

12.2 Using *78K0R-Link It!* Board demo with TMG IO-Link Device Tool. 72

12.2.1 Getting started with the TMG master:..... 72

12.2.2 Updating the IO-Link Device catalog..... 73

12.2.3 Catalog update confirmation..... 74

12.2.4 IO-Link communication set-up..... 74

12.2.5 *78K0R-Link It!* Board sensor demo in IO-Link device tool..... 77

12.2.6 *78K0R-Link It!* Board sensor Teach-in..... 79

CHAPTER 13 CABLES..... 81

13.1 USB interface cable (Mini-B type)..... 81

CHAPTER 14 SCHEMATICS..... 82

CHAPTER 1 INTRODUCTION

The 78K0R–Link It! demonstration kit for the NEC low power 78K0R 16-bit microcontroller family is designed as a development platform for IO-link sensors, and can also be used as an evaluation tool for the 78K0R microcontroller. It allows the development of IO-Link sensor systems based on the 78K0R/KE3-L device. The board is prepared to be connected to user hardware parts, and contains elements to easily start and demonstrate IO-link sensor applications. This includes I/O-functions, i.e. navigator switch, a Temperature sensor, MR Sensor, I/O lines, analog inputs and outputs, UART serial interface and more.

The hardware environment, the applications, will be described in this manual.

A sample Demo illustrating an IO-Link temperature sensor is available.

1.1 Package contents

Link It! board

USB cable

24V power supply

CD-ROM containing the evaluation version of the TMG IO-Link Stack library, an evaluation copy of the IAR Embedded Workbench for 78K with 16Kbyte code size limitation, documentation, and a XML device description file “IO-Link user Interface" to support the Temperature demo in the TMG IO-Link Device tool.

Please verify that you have received all parts listed in the package contents list attached to the *78K0R-Link It!* demonstration kit package. If any part is missing or seems to be damaged, please contact the dealer from whom you received your *78K0R-Link It!*

1. **The Technologie Management Gruppe, TMG (Technologie und Engineering GmbH) stack is for evaluation purposes only. For mass production end products, a full license must be purchased from TMG.**

2. **The TMG IO-Link Master and TMG IO-Link device Tool are referenced in this manual. However , they are not included in the package**

Notes **Please contact TMG directly for details on obtaining the full license, the TMG IO-Link Master and TMG IO-Link device Tool**

Technologie Management Gruppe-Karlshrue ((Technologie und Engineering GmbH)

Internet: www.tmg-karlshrue.de

3. **Please also note that the M12 cable shown in this manual is not included in the package.**

1.2 Features

NEC Electronics µPD78F1009 low power consumption general purpose NEC 16-bit 78K0R MCU

NEC Electronics µPD78F0730 MCU with on-chip USB interface

E98110A Elmos IO-Link Transceiver

4 x 7 segments LEDs driven by serial interface.

Power Supply by USB interface, external power supply, or M12 cable.

On-Board debug function (TK-78K0R debugger)

The 78K0R–Link It! board supports an On-Board debug function by using the IAR C-SPY debugger without a need of additional debug hardware. It allows FLASH downloading and standard debug functions like code execution, single stepping, breakpoints, memory manipulation etc.

The IAR Embedded Workbench for 78K and the IAR C-SPY debugger / simulator are included. These packages are restricted in such that maximum program code size is limited to 16 Kbyte.

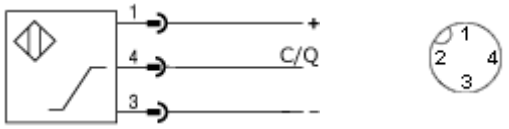
Full documentation is included for the NEC 78K078F1009 microcontroller, NEC 78K0 78F0730 microcontroller, IAR Systems Embedded Workbench and IAR Systems C-SPY debugger / simulator.

TMG IO-Link Stack Library (Evaluation version).

IO-Link communication

The *78K0R–Link It! board* provides an IO-Link communication channel

Current type:	-	DC
Wiring:	-	3-Wire
Output signal:	-	IO-Link
Rated operational voltage:	V	24DC
Supply voltage:	V	18…30 DC
Short circuit protection:	-	yes
Protected against polarity rev:	-	yes



IO-Link Data

Physical Layer:		PHY2
Data Transfer Rate:	-	COM1 (4.8kBaud), COM2 (38.4kBaud), COM3 (230.4kBaud)

Board size: 135mm x 60mm

Power supply by USB interface option for Microcontroller.

Analog to digital signal conversion

Various input / output signals available, such as

I/O ports prepared to be connected to user hardware

Timer input / output signals

Two or three wires serial I/O

Analog input lines

Navigation switch

Virtual UART interface, via the µPD78F0730 78K0 8-bit microcontroller with on-board USB interface

The IAR Embedded Workbench for 78K and the IAR C-SPY debugger / simulator are included. These packages are restricted in such that maximum program code size is limited to 16 kByte.

Full documentation is included for the NEC 78K0R/KE3-L microcontroller, IAR Systems Embedded Workbench and IAR Systems C-SPY debugger / simulator.

The *78K0R–Link It!* is not intended for code development. NEC does not allow and does not support in any way any attempt to use *78K0R–Link It!* in a commercial or technical product.

1.3 System requirements

HOST PC	A PC supporting Windows 2000 or Windows XP is required for the IAR systems Embedded Workbench demo-version. A Pentium processor with at least 1 GHz CPU performance, with at least 256 Mbytes of RAM, allowing you to fully utilize and take advantage of the product features. 500 Mbytes of free disk space, and an additional 10 Mbytes of free disk space on the Windows system drive. A web browser and Adobe Acrobat Reader to be able to access all the product documentation.
Host Interface	USB interface that enables communication based on USB (Ver1.1 or later)

Notes Updates of the IAR Embedded Workbench for 78K, documentation and/or utilities for *78K0R -Link it!*, if available, may be downloaded from the NEC WEB page(s) at: http://www.eu.necel.com/update?id=307

1.3.1 Optional system requirements

User may choose to purchase the following additional equipments for the development of IO-Link applications:

TMG USB IO-Link Master

PC software- TMG IO-Link Device Tool for configuration and analysis.

Please contact TMG directly for details on the TMG IO-Link Master and TMG IO-Link device Tool

Internet: www.tmg-karlshrue.de

Double Ended 4 pins M12 cable.

1.4 Trademarks

IAR Embedded Workbench, visualSTATE, IAR MakeApp and C-SPY are registered trademarks of IAR Systems AB. Microsoft and Windows are registered trademarks of Microsoft Corporation. Adobe and Acrobat Reader are registered trademarks of Adobe Systems Incorporated.
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CHAPTER 2 78K0R–*LINK IT*! SYSTEM CONFIGURATION

The IO-link standard is a point to point based communication, where a master and a slave device exchange information over a communication channel. The master initiates and organizes the data exchange. The slave treats the master's request and replies accordingly.

The *78K0R–Link It!* board (slave device) is based on the NEC's latest 16-bit 78K0R/KE3-L microcontroller family

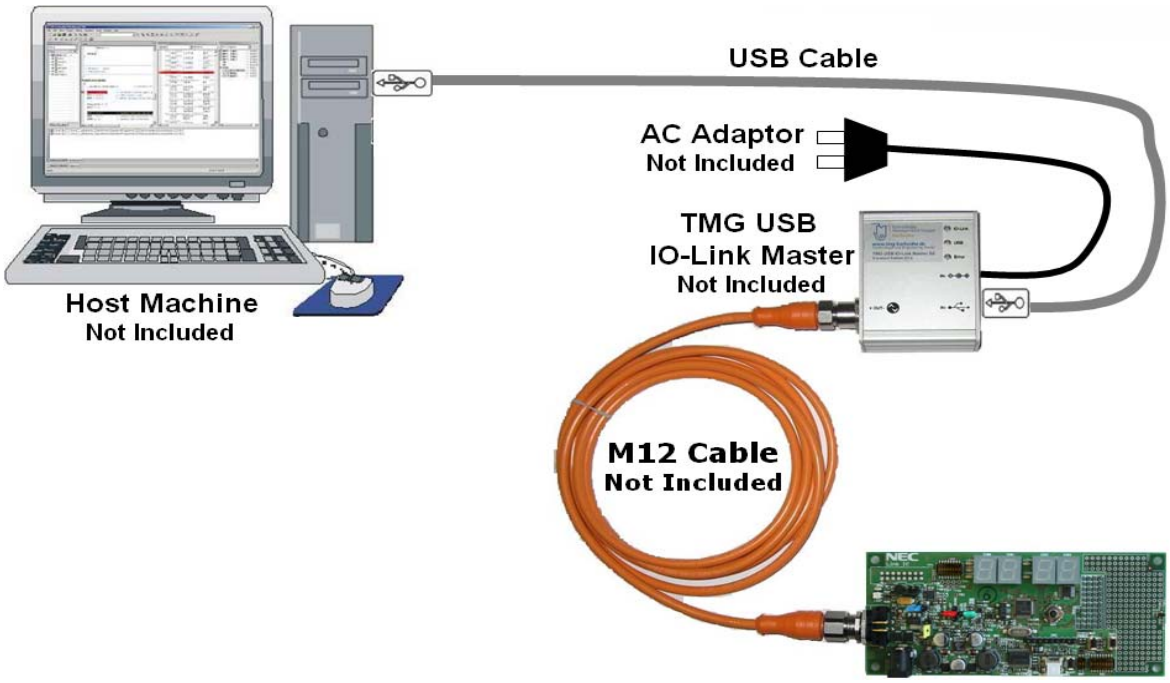


Figure 2-1. IO-Link system configuration

2.1 78K0R–Link It! board

78K0R–Link It! board is a demonstration kit for the 78K0R/KE3-L 16-bit microcontroller of the 78K0R family. The IO-link board can be used in two modes: IO-Link Mode (default mode), and Standalone mode.

2.1.1 IO-Link Mode

When used in IO-Link Mode, the *78K0R–Link It! board* is connected to a host system via an IO-Link Master. Figure 2-1 shows the board being connected to a host computer using the TMG USB IO-Link Master (not included: see section **1.3.1. Optional system requirements** for more details).The Master powers and connects to the demonstrator board via the M12 connector using a M12 cable (not included). The board will be working as an IO-link sensor demonstrating the application stored in the Microcontroller's memory.

2.1.2 Standalone Mode

When the board is not used in an IO-link application, the board is in "standalone mode". In this mode, the user can use the microcontroller for application development and debugging. The demonstration board is connected to the host system via USB interface with USB cable provided, See. Figure 2-2. The host system may be used for On-Chip debugging by using the IAR C-SPY debugger and to allow execution of application programs on *78K0R–Link It!* board. It is also used to power the board.

Caution **In "standalone mode", the M12 cable must be disconnected and an AC adapter may be used to power the board if more than 500mA (USB maximum current load) is required**

Remark **The user can optionally use an external AC adapter, the MINICUBE2(not included), or the USB interface, to provide power to the board. See Table 3-1. Power supply selector, JP1 configuration for details**

The microcontroller on the board can run at up to 20 MHz operating speed. The sub-clock is provided with a 32.768 kHz. A 18.432MHz external crystal is also available as main clock.

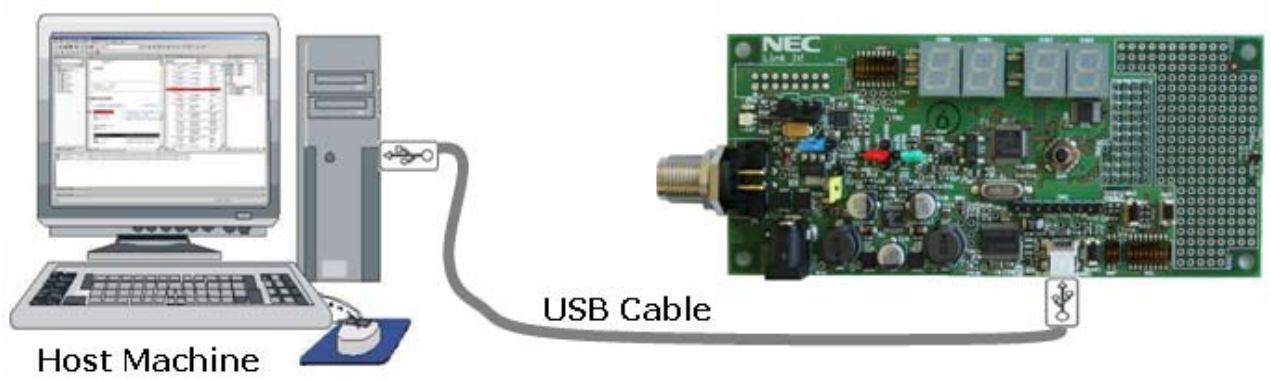


Figure 2-2. USB Powered configuration

2.2 Host computer

The USB host interface enables communication to the *78K0R–Link It!* board. The µPD78F0730, 78K0 8-Bit microcontroller with on-chip USB interface and the NEC virtual UART driver allows application software to access the USB device in the same way as it would access a standard RS232 interface. The NEC virtual UART driver appears to the windows system as an extra Com Port, in addition to any existing hardware Com Ports.

2.3 Power supply via USB interface

The *78K0R-Link it!* board can be powered by the USB interface. Optionally the board can be powered by the QB-MINI2 On-Chip debug emulator as well as an external power supply.

Caution **A different power source must be used to power the board if more than 500mA (USB maximum current load) is required**

CHAPTER 3 78K0R–LINK IT! COMPONENTS

The *78K0R–Link It!* board is equipped with a variety of components allowing a user to develop sensor applications. These components include: Timer input / output signals, Two or three wires serial I/O, 7 segments numeric displays, LEDs, Power LED, 2 push buttons for external interrupts generation (SW2 and SW3), Dip Switch for control of operating modes of the board, Reset button, wrap area for external user hardware, multi directional Joystick(SW4).

Most I/O ports on the 78K0R/KE3-L microcontroller are prepared to be connected to user hardware.

Several connectors are available in order to be connected to host computers, FLASH programmer or any external target hardware.

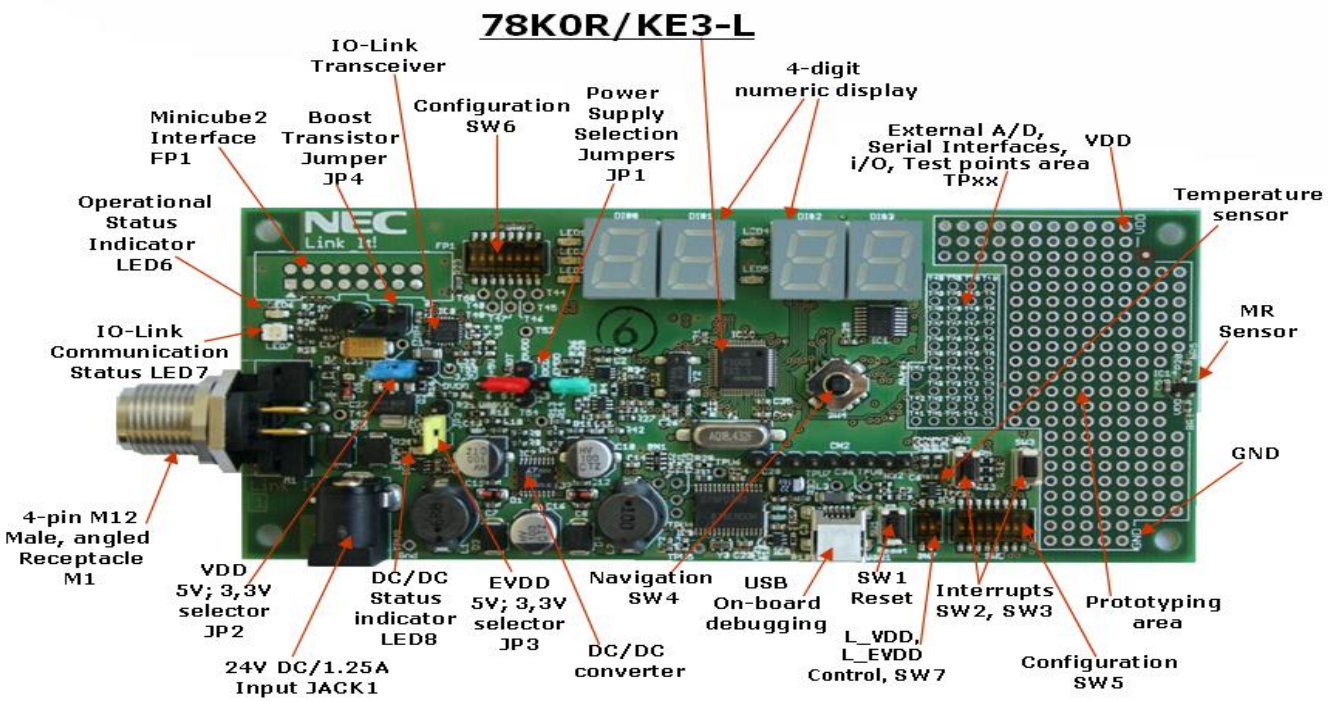


Figure 3-1. 78K0R-IO-Link board Components

3.1 Power Supply Selector JP1

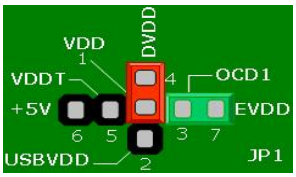


Figure 3-2. Power Supply Selector JP1

Jumper JP1 is the power supply selector of the board.

In default mode (IO-Link mode: JP1 1-4 closed) the board is powered by the IO-link Master (not included), via the M12 connector. The board will be working as an IO-link sensor demonstrating the application stored in the Microcontroller's memory.

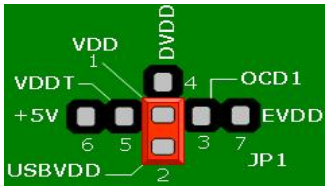
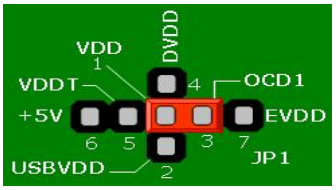
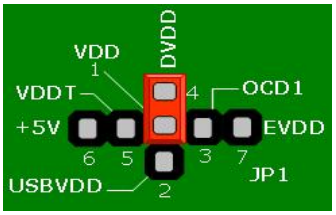
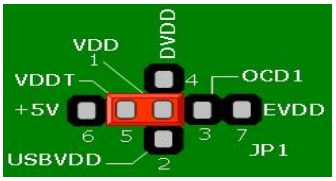
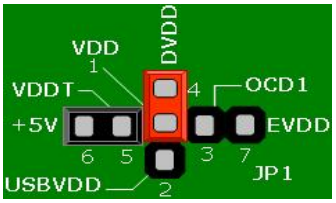
If the board is not used in an IO-link application, the board is in "standalone mode". The user can use the microcontroller for application development and debugging. In "standalone mode", the M12 cable (not included) must be disconnected and an AC adapter may be used to power the board.

Additionally, if an AC adapter is not available to be used in standalone mode, the user can optionally use the MINICUBE2, or the USB interface, to provide power to the board.

When powered from the M12 connector or the AC Adapter, the user can then select whether to provide the VDD voltage rail to the microcontroller, from the regulator output from the IO-Link transceiver or the DC/DC Converter available on the board. LED6 lights up when power is apply to VDD, by setting JP1.

The table below summarizes the configuration options for the power supply selector JP1.

Table 3-1. Power supply selector, JP1 configuration

JP1	configuration	Power Supply Source
1-2		Power supply from USB via connector USB1 (5V VDD for 78K0R/KE3-L from USB1) **The IO-Link transceiver transmitter is disabled if VDD_IO is below VDD_IO_UV(Please refer to the E98110 datasheet available on the CD-ROM for more details)**
1-3		MINICUBE2 via OCD1 connector (Note2). (5V VDD for 78K0R/KE3-L from OCD1) **IO-Link transceiver transmitter is disabled if VDD_IO is below VDD_IO_UV(Please refer to the E98110 datasheet available on the CD-ROM for more details)**
1-4		M12 cable via M12 connector or AC Adaptor from Jack1 (5V VDD for 78K0R/KE3-L from DC/DC converter: Discrete VDD) Internal regulator of IO-Link transceiver used by the transceiver only **JP4 (pins 1 and 2) must be closed.**
1-5		M12 cable via M12 connector or AC adaptor via Jack1 (5V VDD for 78K0R/KE3-L from internal regulator of IO-LINK Transceiver) **1. Q1 has to be mounted on the board (Note1),** **2. JP4 (pins 2 and 3) must be closed.**
1-4, 5-6		Board Power supply from M12 via M12 connector or AC Adaptor via Jack1 (Transceiver's 5V VDD from DC/DC converter: Internal regulator of transceiver not used) **1. JP4 must be opened.** **2. The Black Jumper must be moved to pins 5 and 6**

Note 1 An additional NPN transistor (not mounted), must be used. Care must be taken to evaluate current consumption when choosing this transistor. If the transistor gets destroyed, other components connected to the 5V rail on the board may also be destroyed.

Note2 By supplying power from the MINICUBE2, external hardware must not be connected to the board. Within this mode the board can operate without external power supply from USB

3.2 Discrete Voltage rail selector, JP2

JP2, configures the voltage level (DVDD), provided by the DC/DC converter to power the board. The user has the choice between 3.3V and 5V.

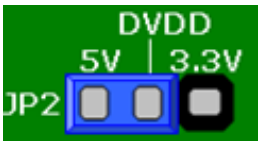


Figure 3-3.DVDD selector, JP2

Table 3-2: DVDD, JP2 Pin configuration

JP2	configuration	Discrete VDD (DVDD)
1-2	Closed (Default)	DVDD = 5V
2-3	Closed	DVDD = 3.3V

3.3 I/O port voltage control, JP3

Use JP3 to apply 3.3V or 5V to the I/O port reference input pin EVDD of the 78K0R/KE3-L. A different reference voltage may also be applied by using an external power source.

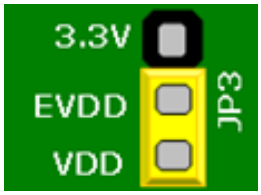


Figure 3-4. EVDD selector, JP3

Table 3-3: EVDD, JP3 Pin configuration

JP3	configuration	Voltage
1-2	Closed (Default)	EVDD = VDD
2-3	Closed	EVDD = 3.3V

3.4 VDD Transceiver selector , JP4

JP4 controls the transceiver's VDD voltage usage.

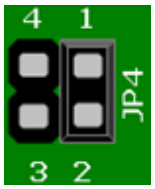


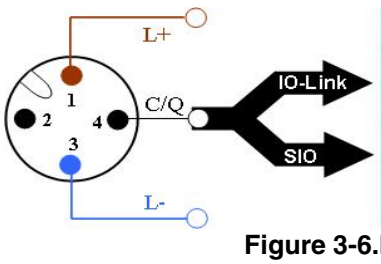
Figure 3-5. VDD Transceiver selector, JP4

Table 3-4: VDD Transceiver, JP4 Pin configuration

JP3	configuration	Voltage
1-2	Closed(Default)	internal regulator active
2-3	Closed	external Transistor Q1 active (not supported)
1-2-3-4	Opened	external supply of VDD: internal regulator inactive

3.5 M12 Connector, M1

The M12 connecter allows the board interfacing with an industrial type master device. Figure 3-6 gives the wiring scheme for the plug. Pin 2 is not currently used for IO-Link. This pin is connected to Test pad T43 for future use.



PIN	Signal	Remark
1	L+	24 Volt
2		
3	L-	Ground
4	C/Q	Communication / switching signal

Figure 3-6.M12 wiring scheme

3.6 USB interface connector, USB1

This interface allows connecting the IAR C-SPY debugger to the board in order to use the On-Board debug function (TK-78K0R debugging). The TK-78K0R interface supports On-board FLASH erasing / programming and standard debug features like code execution, single stepping, breakpoints, memory manipulation etc.

For standard communication to a host computer - i.e. by using a terminal program - the input/output signals of UART1 of the 78K0R/KE3-L device can be redirected to the USB1 connector via the µPD78F0730 USB microcontroller.

The power supply of the board can also be provided by the USB1 connector.

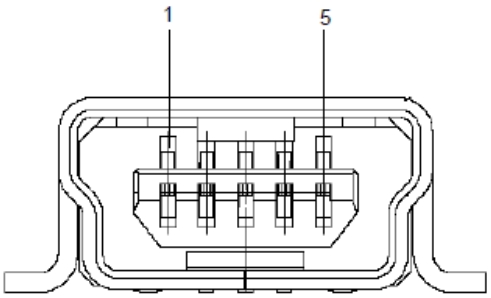


Figure 3-7. USB1, USB Mini-B Type Host Connector Pin Configuration

Table 3-5. Pin Configuration of Connector USB1

Connector USB1	Signal Name
1	VBUS
2	D-
3	D+
4	N.C.
5	GND

3.7 RESET button, SW1

SW1 is the reset button. It activates the power on reset. Switch SW1 controls the reset input signal of the 78K0R/KE3-L microcontroller.

Beside the reset switch, the 78K0R/KE3-L can also be reseted by the on-board debugging interface via the uPD78F0730 microcontroller, and by the on-chip debugging interface, via the FP1 connector.

3.8 (INTP0) Switch, SW2

SW2 is a push button connected to external interrupt input INTP0 of the microcontroller. This is equal to port “P120/INTP0/EXLVI” of the 78K0R/KE3-L device. The port may be programmed to generate the external interrupt INTP0.

3.9 (INTP4) Switch, SW3

SW3 is a push button connected to external interrupt input INTP1 of the microcontroller. This is equal to port “P70/KR0/SO01/INTP4” of the 78K0R/KE3-L device. The port may be programmed to generate the external interrupt INTP4.

3.10 Navigation switch, SW4

Button SW4 is a navigation switch connected to the 78K0R/KE3-L device. It operates in four directions and has a center push function. When the navigation switch is moved to one of the four directions or it is pushed a low-level signal (Vss) is applied to the corresponding pin of the 78K0R/KE3-L device. The connection of SW4 to the microcontroller is shown in the table below.

The switch can be used for sensor application parameterization

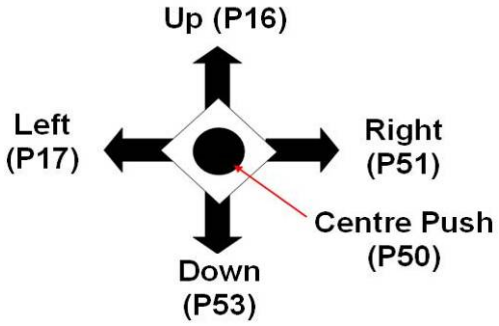


Figure 3-8. SW4, Navigation switch

Table 3-6. SW4, Navigation switch Pin configuration

SW4	Pin Connection to the 78K0R/KE3-L device
Up	P16
Left	P17
Right	P51
Center Push	P50
Down	P53

3.11 Configuration switch, SW5

The different operation modes of the board can be set by switch SW5/bit1-10.

Table 3-7. Configuration switch SW5, default settings

SW5/bit	Factory settings	Mode
1	OFF	Standalone and debug Mode (Note1)
2	OFF	Disable TK-78K0R debugger functions
3	OFF	Disable TK-78K0R debugger functions
4	OFF	TxD1 Disconnected from TK-78K0R debugger
5	OFF	RxD1 Disconnected from TK-78K0R debugger
6	ON	SCL0 Connected to display driver
7	ON	SDA0 Connected to display driver
8	OFF	AVREF Disconnected from VDD(Note2)
9	OFF	Disable TK-78K0R debugger functions
10	OFF	Disable TK-78K0R debugger functions

Notes

1. **USB cable not connected**
2. **The board is shipped from factory with a 2.5V reference voltage rail applied to AVREF, via R40.**

3.11.1 Standalone / debug mode selection, SW5/bit1

Switch SW5/bit1 controls the operation mode of the board, when a USB cable is connected to USB1, and the TK-78K0R Debugger is used.

Switch SW5/bit1 to ON sets the board to “stand-alone mode”.

Within this mode, the 78K0R/KE3-L RESET can be controlled by the user via switch SW1 and by the IAR C-SPY debugger. The program stored in the internal FLASH memory of the 78K0R/KE3-L microcontroller is executed. The usage of the On-Board debug function (TK-78K0R debugging) is also supported within the “stand-alone mode”.

Switch SW5/bit1 to OFF sets the board to the “debug mode” exclusively.

Within this mode the 78K0R/KE3-L device is permanently held within RESET state. Only the IAR C-SPY debugger can control the RESET signal within this mode. The RESET switch SW1 is inactive.

Table 3-8. Operation mode selection SW5/bit1

SW5/bit1	Mode
ON	Standalone and debug mode
OFF	Debug mode only

3.11.2 On-Board debug function via USB selection, SW5/bit2 – bit3 – bit9 – bit10

SW5/bit2 bit3, bit9 and bit10 are controlling the TK-78K0R Debugger interface with the 78K0R/KE3-L

Switch SW5/bit2 and bit3 ON, to enable On-Board debugging via USB.

Within this mode a dedicated single-line UART (pin Tool0) of the 78K0R/KE3-L is connected to the µPD78F0730 USB microcontroller. Pin Tool0 of the 78K0R/KE3-L microcontroller is reserved for on-board FLASH programming and debugging purpose.

Switch SW5/bit2 and bit3 OFF to disconnect the single-line UART from the µPD78F0730 USB microcontroller.

Within this mode, no debugging is supported. The user can establish standard serial communication via UART1 to a terminal program running on the HOST PC (see **section 3.11.3** for more details).

Switch SW5/bit9 controls the RESET signal of the TK-78K0R debugger

Switch SW5/bit10 controls the FLMDO signal of the TK-78K0R debugger

Switch SW5/bits 9 and 10 ON, only when the TK-78K0R debugger is used

Table 3-9. (TK-78K0R debugging) configuration, SW5/bit2 - bit3 – bit9 – bit10

SW5/bit2 - bit3 - bit9 - bit10	Mode
OFF	Disable TK-78K0R debugger functions
ON	Enable TK-78K0R debugger functions

3.11.3 UART mode selection, SW5/bit4-bit5

The user can establish standard serial communication via UART1 to a terminal program running on the HOST PC.

Switch bit4 and bit5 of SW5 ON or OFF to respectively connect or disconnect the UART1 signals RxD1 and TxD1 of the 78K0R/KE3-L, to the µPD78F0730 USB microcontroller.

Within this mode, standard serial communication to a terminal program running on the HOST PC can be established.

Note: when communication with the Host PC is required, the user must ensure the On-board debugging function is disabled (see section 3.11.2 for more details).

Table 3-10. UART mode selection, SW5/bit4-bit5

SW5/bit4	SW5/bit5	Mode
OFF	OFF	Disconnect UART1 signals from TK-78K0R debugger
ON	ON	Connect UART1 signals to TK-78K0R debugger

3.11.4 Display Driver control, SW5/bit6-bit7

Switch SW5/bit6-bit7 control the I²C interface between the 78K0R/KE3-L and the 7-segments displays driver.

Switch bit6 and bit7 ON or OFF to respectively connect or disconnect the display driver to the 78K0R/KE3-L.

Table 3-11. Display Driver control, SW5/bit6-bit7

SW5/bit6	SW5/bit7	Mode
OFF	OFF	Disconnect 7-segments display driver
ON	ON	Connect 7-segments display driver

Caution The Display driver must be powered when the 7-segment displays are used to display information. Please refer to section 3.13 for more details.

3.11.5 AVREF control, SW5/bit8

Switch SW5/bit8 controls the voltage reference source for the analog input of the 78K0R/KE3-L

Switch bit8 ON or OFF to respectively apply or disconnect VDD to AVREF.

Table 3-12. AVREF control, SW5/bit8

SW5/bit8	Mode
OFF	AVREF disconnected from VDD (Note1)
ON	AVREF = VDD

Notes

1. **The board is shipped from factory with a 2.5V reference voltage rail applied to AVREF, via R40.**

3.12 Transceiver Configuration Switch SW6

SW6 serve two purposes.

It allows to isolate the IO-Link transceiver from the 78K0R/KE3-L microcontroller by disconnecting the communication interface

It put the DC-DC converter in power down mode when it is not needed by the user

Please refer to the coming sections for more details on SW6.

3.12.1 DC-DC power down control, SW6/bit1

The IO-Link master provides a 24V voltage rail to the board. A DC/DC converter steps down that voltage to provide the 5V, and 3.3V power supplies for the board.

The board is equipped with dual current mode PWM step-down DC/DC converter with internal power switches capable of generating two 1.4A outputs. Switch SW6/bit1 turns DC-DC converter ON/OFF.

Table 3-13. DC-DC power down control, SW6/bit1 configuration

SW6/Bit1	Setting	DC-DC Converter
1	ON	DC-DC converter active
1	OFF	DC-DC converter inactive

LED8, lights up when power switch SW6/bit1 is ON to indicate that the DC–DC converter is active.

3.12.2 Transceiver bypass control, SW6/bit2-8

Switch SW6/bit2to bit8 allow the user to connected/disconnect the IO-Link transceiver to/from the 78K0R/KE3-L microcontroller.

Table 3-14. Transceiver bypass control, SW6/bit2-bit8 Pin configuration

SW6 Bit	Setting	IO-Link Transceiver	78K0R/KE3-L pin
2	ON/OFF	VDD_IO	EVDD connected / disconnected
3	ON/OFF	TxEN	P76/KR6 connected / disconnected
4	ON/OFF	SPEED	P77/KR7 connected / disconnected
5	ON/OFF	TxD	TxD0 connected / disconnected
6	ON/OFF	RxD	RxD0 connected / disconnected
7	ON/OFF	WAKE	P72/INTPU6 connected / disconnected
8	ON/OFF	ILIM	P71/INTPU5 connected / disconnected

3.12.3 IO-Link Transceiver

The transceiver has two functions. It is used firstly as an IO-Link port Analog front-End. It ensures the analog front end of the IO-Link communication channel by transforming the 3-wire 24V of the M12 IO-link port to a digital interface for the 78K0R/KE3-L device.

Secondly, it can be used as a power supply source:

The communication and the power supply run via 3 separate lines to the IO-Link Master. The integrated voltage regulator is able to provide up to 5mA current for external purposes. With an optional external boost transistor (not mounted on the board), it is possible to supply external devices with a higher current consumption.

Caution **The user must be aware of the current consumption of the application and the maximum current rate of the boost transistor, if using this feature. Since a destruction of the boost transistor, may also cause the destruction of other devices connected to the 5V voltage rail provided by the boot transistor.**

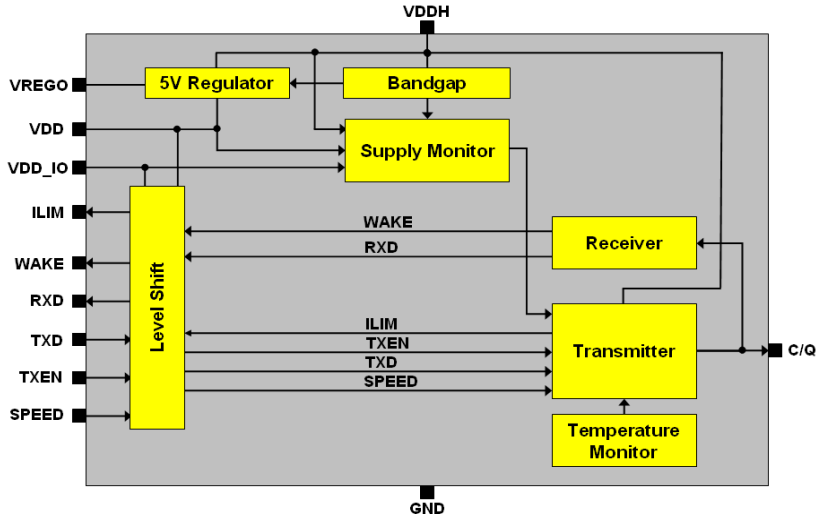


Figure 3-9. IO-Link Transceiver Block Diagram

Further details on the transceiver can be found in the E981.10 datasheet available on the Link-It CD-ROM

3.13 Digital logic Power Supply switch, SW7

SW7 is a 2-bits switch used to control respectively, the power supplies (L_VDD, L_EVDD) for the 7 segments displays driver, and the digital logic interface between the USB microcontroller (uPD78F0730) and the 78K0R/KE3-L.

Switch bit1, bit2 to ON or OFF to apply or disconnect VDD and EVDD to L_VDD, and L_EVDD respectively.

Table 3-15. SW7 Digital Logic supply configuration

SW7/Bit1-Bit2	Setting	Power supply
1	ON(Factory setting)	L_VDD = VDD(7-seg display and LED7 active)
	OFF	L_VDD Disconnected (7-seg display and LED7 inactive)
2	ON	L_EVDD = EVDD(USB microcontroller interface active)
	OFF(Factory setting)	L_EVDD Disconnected(USB microcontroller interface inactive)

3.14 4-digit Numeric Display

The numeric display allows hexadecimal fonts displaying of metering information such as, distance, temperature, time. It is made of 4 single 7 segments displays and 5 discrete LEDs.

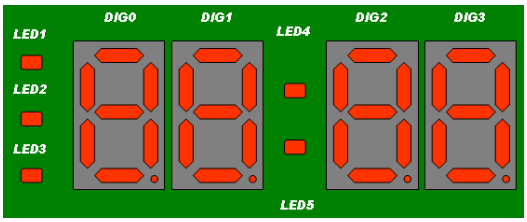


Figure 3-10. 4-digit Numeric Display

LED1 to LED3 can be used to provide common Alarm, AM, PM types of functions, or any user defined function.

The colon segment LED4 and LED5 are connected in parallel and driven together as one LED.

The 7 segments display and discrete LEDs are driven by a display driver. This display driver interfaces with the 78K0R/KE3-L via an I²C interface. see section 3.11.4 for details. For more details on the display driver, please refer to the datasheet provided on the Link-It CD-ROM.

3.15 Power LED, LED6

LED6, lights up when power is supplied to the *78K0R–Link It!* by setting JP1.See **section 3.1** for details.

3.16 IO-Link Communication indicator, LED7

LED7 is a bi-color LED connected to pins P42, P43, to indicate the activities on the communication channel.

By default the LED is lighted up with an amber color, when the microcontroller is not programmed and power is provided to L_VDD via switch SW7 bit1. The table below shows the defined LED colors and indications for the board, when an IO-Link application is downloaded to the microcontroller.

Table 3-16. LED7 indications for IO-Link port signals

Signal	IO-Link communication
Pin 4 "C/Q line"	Dark (OFF) : (Device disconnected or Fault on C/Q line: Rx not connected) Green (ON) : (Data exchange ok) Red (ON) : (Fault on C/Q line TX disconnected

3.17 External main oscillator, Y1

The 78K0R/KE3-L can run at up to 20 MHz operating speed , and The clock generator can be configured to work with a 18.432MHz external oscillator connected between the X1 and X2 pins.

The sub-clock is provided with 32.768 kHz to pins XT1 and XT2 of the 78K0R/KE3-L device.

3.18 Test pads, T1~T42 area and wrap field

Several pins of the 78K0R/KE3-L microcontroller are connected to the test pads T1~T42 area. The corresponding assignment can be found in tables below. Additionally the *78K0R-Link it!* board provides a wire wrap field area allowing the integration of additional application hardware.

VDD, GND, and an MR sensor are also available this area.

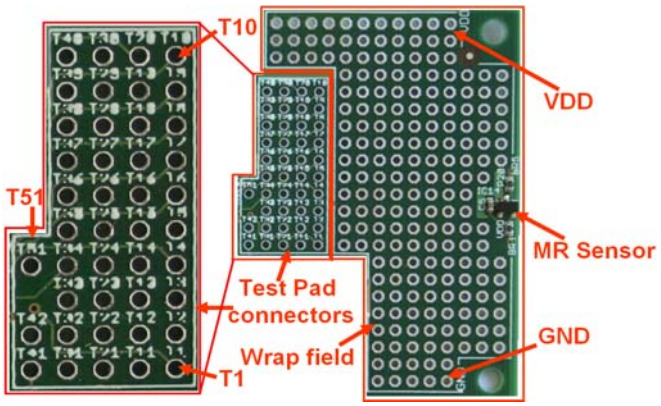


Figure 3-11.Test pad area and wrap field

Table 3-17. Test Pads Tables

Test pads	78K0R/KE3-L I/O pin
T1	P140 / PCLBUZ0
T2	P141 / PCLBUZ1
T3	P00 / TI00
T4	P01 / TO00
T5	P20 / ANI0
T6	P21 / ANI1
T7	P22 / ANI2
T8	P23 / ANI3
T9	P24 / ANI4
T10	P25 / ANI5
T11	P26 / ANI6
T12	P27 / ANI7
T13	P150 / ANI8
T14	P151 / ANI9
T15	P152 / ANI10
T16	P153 / ANI11
T17	P80 / CMP0P / INTP3 / PGAI
T18	P81 / CMP0M

Test pads	78K0R/KE3-L I/O pin
T19	P82 / CMP0M /. INTP7
T20	P83 / CMP1M
T21	P10 / TI02 / TO02
T22	P11 / TI03 / TO03
T23	P12 / TI04 / TO04 / RTCDI / RTCLL
T24	P13 / TI05 / TO05
T25	P14 / TI06 / TO06
T26	P15 / TI07 / TO07
T27	P52 / RTC1HZSL / STLI / SLTO
T28	P71 / KR1 / SIO1 / INTP5
T29	P72 / KR2 / SCK01 / INTP6
T30	P73 / KR3 / SO00 / TxD0
T31	P74 / KR4 / SI00 / RxD0
T32	P77 / KR7
T33	P76 / KR6
T34	P75 / KR5 / SCK00

Test pads	78K0R/KE3-L I/O pin
T35	P33
T36	P32 / SCK10 /SCL10 INTP2
T37	P31 / SI10 / RxD1 / SDA10 / INTP1
T38	P30 / SO10 / TxD1
T39	P61 /SDA0
T40	P60 / SCL0
T41	P42
T42	P43
T43	Pin2 M12 connector
T44	ILIM Transceiver
T45	WAKE Transceiver
T46	RxD Transceiver
T47	TxD Transceiver
T48	SPEED Transceiver
T49	TxEN Transceiver
T50	VDD_IO Transceiver
T51	AVREF

3.19 MR (magneto-resistive) Sensor

A MR sensor is a magneto-resistive sensors integrated circuits in small packages. It can be used in position detection applications, using non-contact type sensor. The MR sensor outputs a digital signal to pin P32/SCK10/SCL10/INTP2 of the 78KR0/KE3-L device

3.20 Temperature sensor

For temperature measurement and primarily as an application example, the *78K0R–Link It!* board is equipped with a temperature sensor IC. The output pin of the temperature sensor is connected to pin P153/ANI11 of the 78KR0/KE3-L device.

3.21 PG-FP4 /PG-FP5 / QB-MINI2 connector, FP1

Connector FP1 (not mounted) allows connection of the PG-FP4/PG-FP5 FLASH programmers to the board in order to program application software into the 78K0R/KE3-L internal flash memory.

Remark , The PG-FP4 /PG-FP5 FLASH programmers are separate product from NEC and are not included in this package.

Additionally, FP1 allows connection of the QB-MINI2 (MINICUBE2 On-Chip debug emulator) to the board in order to use On-Chip debug function of the 78K0R/KE3-L device and program the internal flash memory.

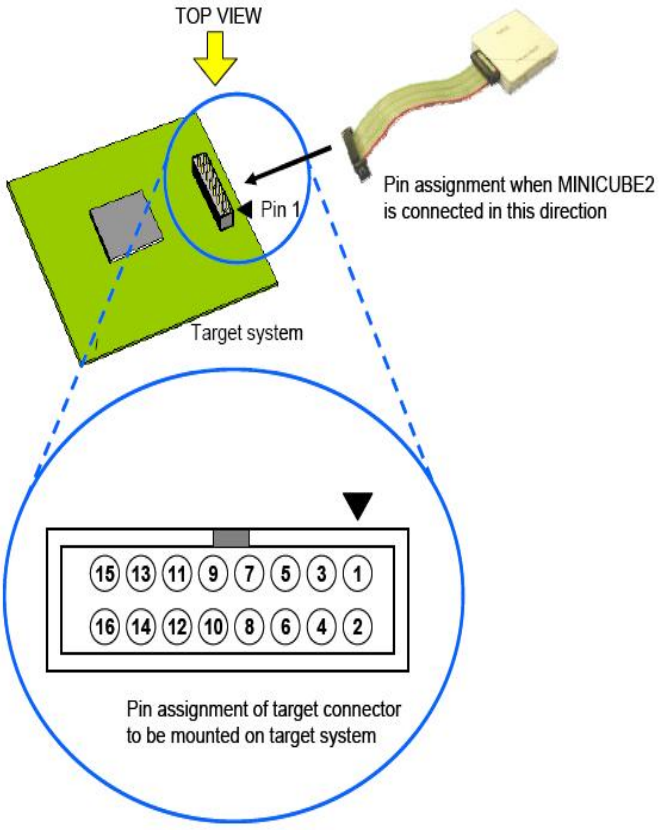

TOP VIEW
Pin 1
Pin assignment when MINICUBE2
is connected in this direction
Target system
15 13 11 9 7 5 3 1
16 14 12 10 8 6 4 2
Pin assignment of target connector
to be mounted on target system

Figure 3-12. FP1, PG-FP4/PG-FP5/Minicube 2 connector

Table 3-18. FP1 pins description

FP1 pin	Function
1	GND
2	RESET
3	SI
4	EVDD
5	SO
6	N.C.
7	N.C.
8	N.C.
9	N.C.
10	N.C.
11	N.C.
12	N.C.
13	N.C.
14	FLMD0
15	RESET_IN
16	CLK_IN

CHAPTER 4 FLASH PROGRAMMING

Flash programming is used to download applications to the internal memory of the 78K0R/KE3-L microcontroller.

This chapter covers the board settings required to perform this operation.

On-chip debugging is documented in the next chapter: Chapter 5. On-Chip debugging

4.1 Flash Programming via MINICUBE2 (QB-MINI2)

When using PG-FP4/PG-FP5 for FLASH programming or QB-MINI2 for FLASH programming /debugging purposes, please configure switch SW7 and SW5 of the *78K0R–Link It!* board as referenced the following tables

Set the Jumpers on the board as shown on **Figure 4-1**: JP1 (VDD=OCD1), JP3 (EVDD=VDD)

JP2 and JP4 are not required if the QB-MINI2 is used to power the board.

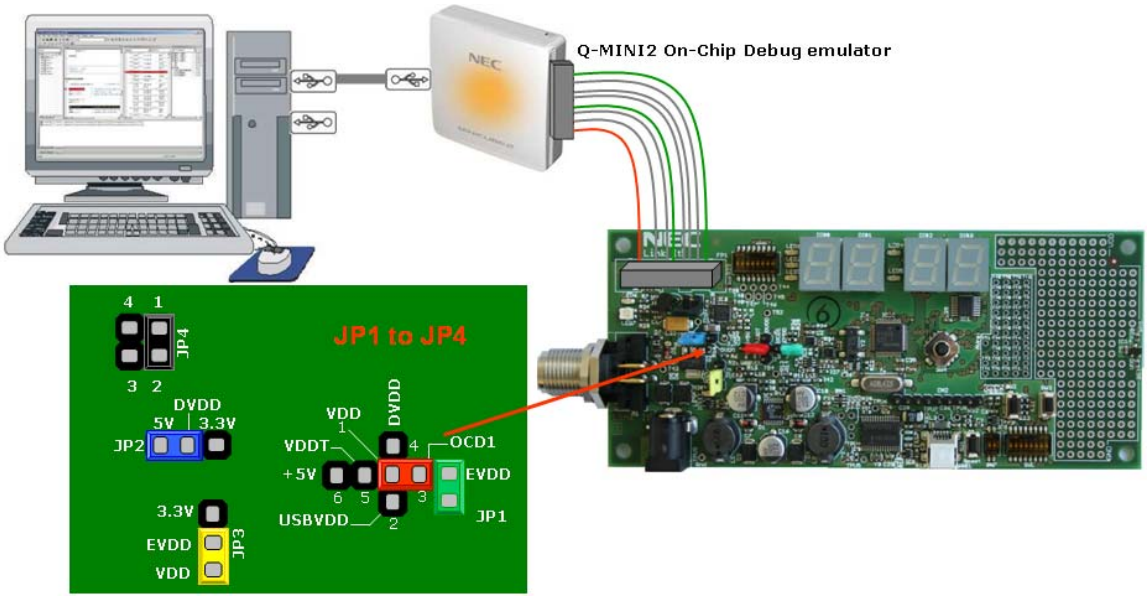


Figure 4-1. Flash Programming via QB-MINI2

Caution The maximum rating current of the MINICUBE2 is 100mA, therefore do not use MINICUBE2 with the target system with the higher current rating.

For applications requiring higher current rate than the maximum rate of the QB-MINI2, please use the power select switch on the Q-MINI2 to set the power supplied to the target system, and use an external power supply to power the board.

Figure 4-2 shows JP1, JP2, JP3, jumper settings used in this configuration:

The Red Jumper is placed on DVDD as power will be provided by the DC DC converter.

The Green jumper is placed between EVDD and OCD1 to provide Q-MIN2 with reference voltage

JP3(EVDD=VDD)

JP2 can be set to 3.3V or 5V

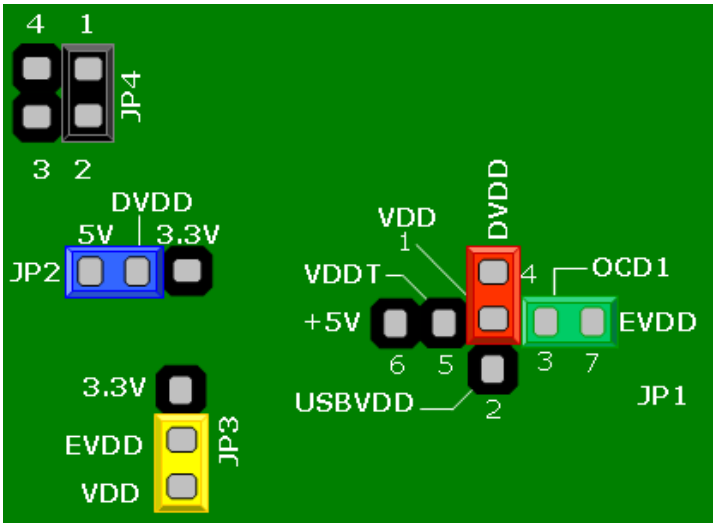


Figure 4-2.Jumper settings for flash programming in high current applications

For more details on the QB-MINI2, please refer to the QB-MINI2 user's manual.

Table 4-1. SW7 configuration for flash programming/On Chip Debugging via QB-MINI2

SW7/Bit1-2	Setting	Power supply
1	ON/OFF (*)	L_VDD = VDD/Disconnected
2	OFF	L_EVDD = Disconnected

(*) = individual selectable by user

Table 4-2. SW5 configuration for FLASH programming via QB-MINI2

SW5 Bit	Setting	Mode
1	ON/OFF (*)	Standalone and debug mode /debug mode only
2	OFF	Disable TK-78K0R debugger functions
3	OFF	Disable TK-78K0R debugger functions
4	ON/OFF (*)	TxD1 connected / disconnected
5	ON/OFF (*)	RxD1 connected / disconnected
6	ON/OFF (*)	SCL0 connected / disconnected
7	ON/OFF (*)	SDA0 connected / disconnected
8	ON/OFF (*)	AVREF applied/not applied
9	OFF	Disable TK-78K0R debugger functions
10	OFF	Disable TK-78K0R debugger functions

(*) = individual selectable by user

4.2 Flash Programming via TK-78K0R debugger

Please refer to **Chapter 10. How to use WriteEZ4 FLASH programming** software**,** for information on setting the board for flash programming using the TK-78K0R debugger.

CHAPTER 5 ON-CHIP DEBUGGING

The 78K0R–Link It! board offers two possibilities to use On-Chip debugging (OCD).

The board supports the QB-MINI2 On-Chip debug emulator in order to use the On-Chip debug function of the 78K0R/KE3-L device. The system configuration for On-Chip debugging is shown in figure below.

Alternatively, the TK-78K0R On-Board debugger allows On-Chip debugging without a need of external debug hardware. Within this mode the default USB connection to the Host computer based on the virtual UART driver is used as debug interface. All standard debug functions are available in the On-Board debugging mode like FLASH programming / downloading, code execution, single stepping, breakpoints, memory manipulation etc.

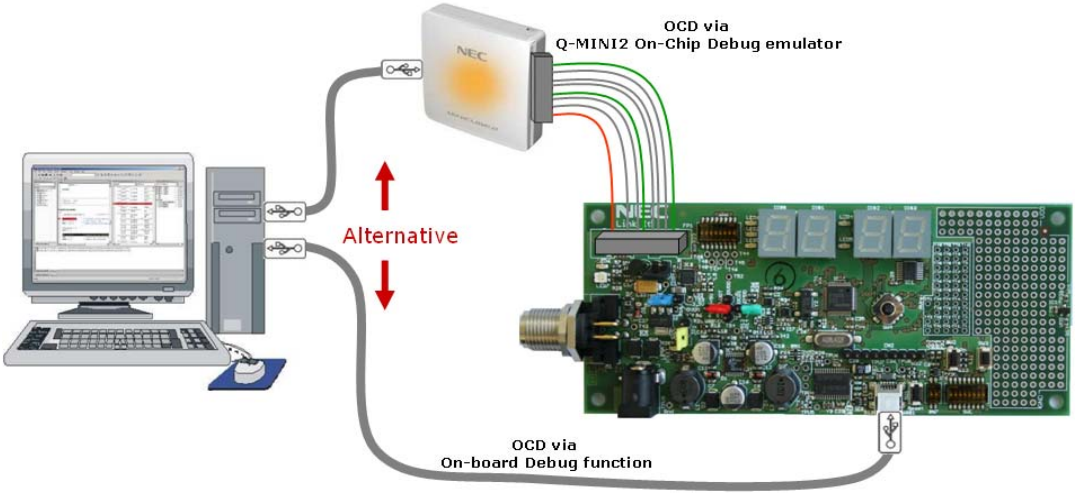


Figure 5-1. On-Chip debugging

5.1 OCD via QB-MINI2 emulator

To operate the board together with the QB-MINI2 On-Chip debug emulator, switch SW5 must be configured as in the following table:

Table 5-1. SW5 configuration for On-chip Debugging via QB-MINI2

SW5 Bit	Setting	Mode
1	ON/OFF (*)	Standalone and debug mode /debug mode only
2	OFF	Disable TK-78K0R debugger functions
3	OFF	Disable TK-78K0R debugger functions
4	ON/OFF (*)	TxD1 connected / disconnected
5	ON/OFF (*)	RxD1 connected / disconnected
6	ON/OFF (*)	SCL0 connected/ disconnected
7	ON/OFF (*)	SDA0 connected/ disconnected
8	ON/OFF (*)	AVREF applied/ not applied
9	OFF	Disable TK-78K0R debugger functions
10	OFF	Disable TK-78K0R debugger functions

(*) = individual selectable by user

5.2 OCD via TK-78K0R On-Board debug function

To operate the board within the On-Board debug mode, switch SW5 and SW7 must be configured as in the following table:

Table 5-2. SW5 Configuration for OCD via TK-78K0R

SW5 Bit	Setting	Mode
1	ON/OFF (*)	Standalone and debug mode /debug mode only
2	ON	Enable On-Board debug function
3	ON	Enable On-Board debug function
4	OFF	TxD1 disconnected
5	OFF	RxD1 disconnected
6	ON/OFF (*)	SCL0 connected/ disconnected
7	ON/OFF (*)	SDA0 connected/ disconnected
8	ON/OFF (*)	AVREF applied/not applied
9	ON	Enable TK-78K0R debugger functions
10	ON	Enable TK-78K0R debugger functions

(*) = individual selectable by user

Table 5-3. SW7 configuration for OCD via TK-78K0R

SW7/Bit1-2	Setting	Power supply
1	ON/OFF (*)	L_VDD = VDD/Disconnected
2	ON	L_EVDD = EVDD

(*) = individual selectable by user

CHAPTER 6 *780R – LINK IT!* INSTALLATION AND OPERATION

6.1 Getting Started

The IAR Embedded Workbench including the C-SPY debugger allows building and downloading application programs to the 78K0R-Linking *it!* Development kit.

Additionally the WriteEZ4 FLASH programming software can be used for simple FLASH programming of the 78K0R/KE3-L internal FLASH memory.

As communication interface between the PC host system and the *78K0R-Link it!* board a standard USB interface line is needed. Before you can download, debug or execute an application program, hardware and software must be installed properly.

6.2 CD-ROM contents

The CD-ROM shows the following directory structure:

Table 6-1. 78K0R–Link It! CD-ROM contents

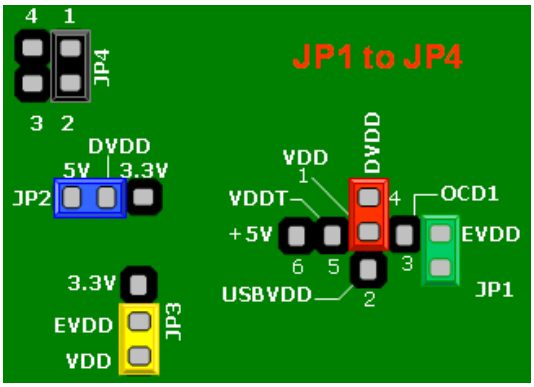
NEC 78K0R–Link It!	CD-ROM ROOT
Acrobat	Acrobat Reader for 32Bit Windows OS
Device file package	µPD78F100964 Device file package
Doc	Documentation
Drivers	USB driver files
IAR Systems	IAR Embedded Workbench for 78K IAR visualSTATE
SamplePrograms	Sample programs for the 78K0R-Link It! Starter Kit IO-Link Temperature sensor demonstration Program Quick start empty project
WriteEZ4	Flash Programmer WriteEZ4 incl. PRM file for µPD78F1009

CHAPTER 7 HARDWARE INSTALLATION

After unpacking the *78K0R–Link It!* development kit, connect the board via connector USB1 to your host computer using the provided USB interface cable. When the *78K0R–Link It!* board is connected, the USB driver needs to be installed on the host machine. Please refer to section, **8.7 USB Driver Installation** for more details.

7.1 *78K0R–Link It!* Factory jumpers and switches Settings

The picture and tables below show the factory setting for the jumpers and switches on the board.



Mode	SW5									
	1	2	3	4	5	6	7	8	9	10
Stand-alone	ON					ON	ON			
		OFF	OFF	OFF	OFF			OFF	OFF	OFF

Mode	SW6							
	1	2	3	4	5	6	7	8
Transceiver connected	ON	ON	ON	ON	ON	ON	ON	ON

Mode	SW7	
	1	2
Display ON	ON	
USB Interface OFF		OFF

CHAPTER 8 SOFTWARE INSTALLATION

The *78K0R–Link It!* package comes with the following software packages:

IAR Systems Embedded Workbench for 78K 16Kbyte code size limited, including C compiler, assembler, linker, librarian and IAR C-SPY debugger / simulator

IAR Systems Visual State time limited demo program

Device file package of µPD78F1009 for IAR Embedded Workbench for 78K

WriteEZ4 flash programmer software including the PRM file for µPD78F1009

IO-Link Temperature sensor demonstration program

The XML Device Description file for IO-Link Device Tool software

The USB Drivers for the *78K0R-Link It!* board

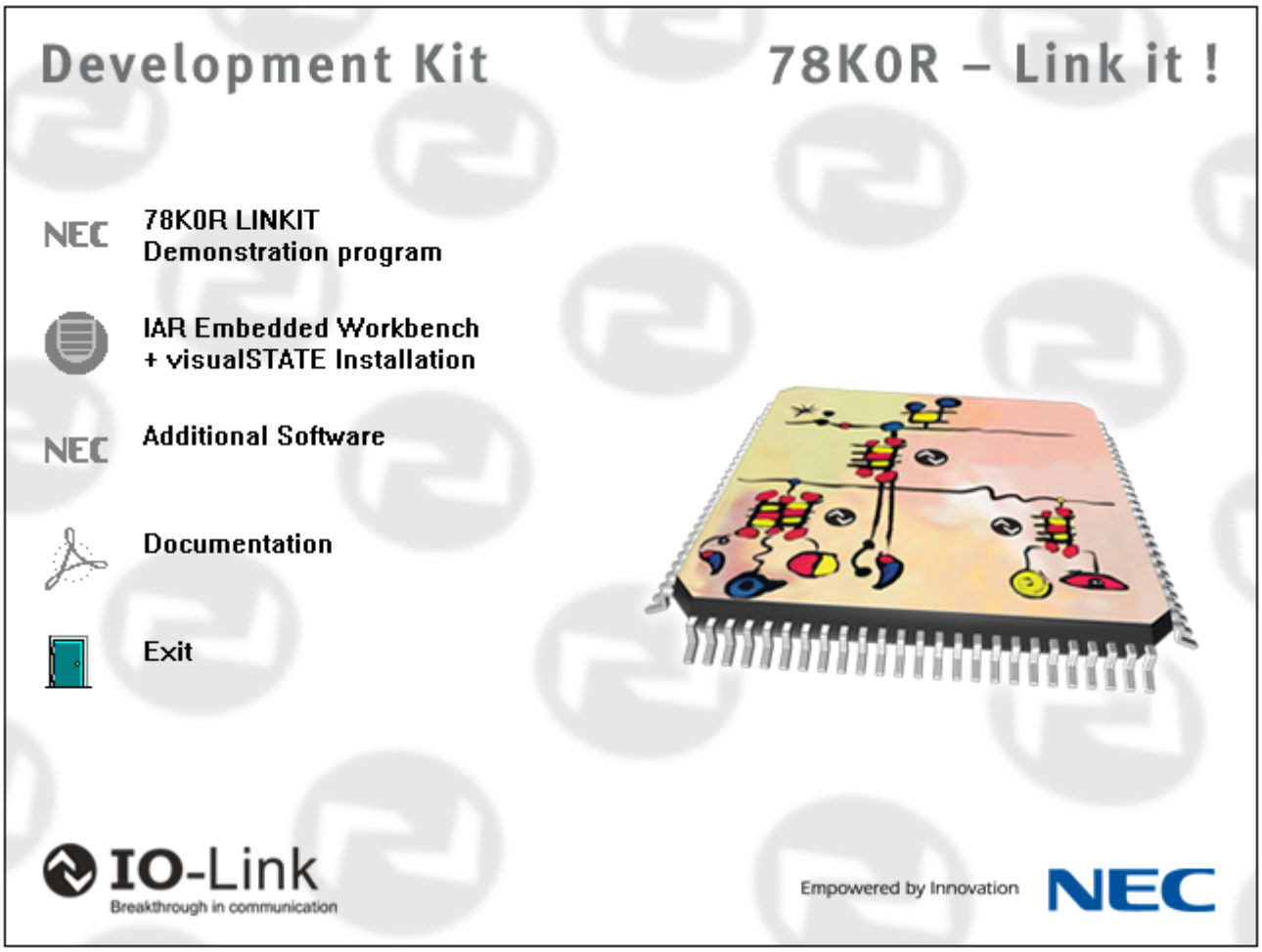


Figure 8-1. *78K0R–Link It!* CD-ROM autorun.exe

8.1 IAR Systems Embedded Workbench for 78K installation

To install the IAR Systems Embedded Workbench for 78K including C-SPY debugger / simulator press the regarding button from the Autorun of the CD-ROM provided within the *78K0R–Link It!* package. The installation can also be started by executing the `Autorun.exe` program in the directory"`\IAR Systems\`" of the CD-ROM.

When running the autorun.exe the following screen appears.

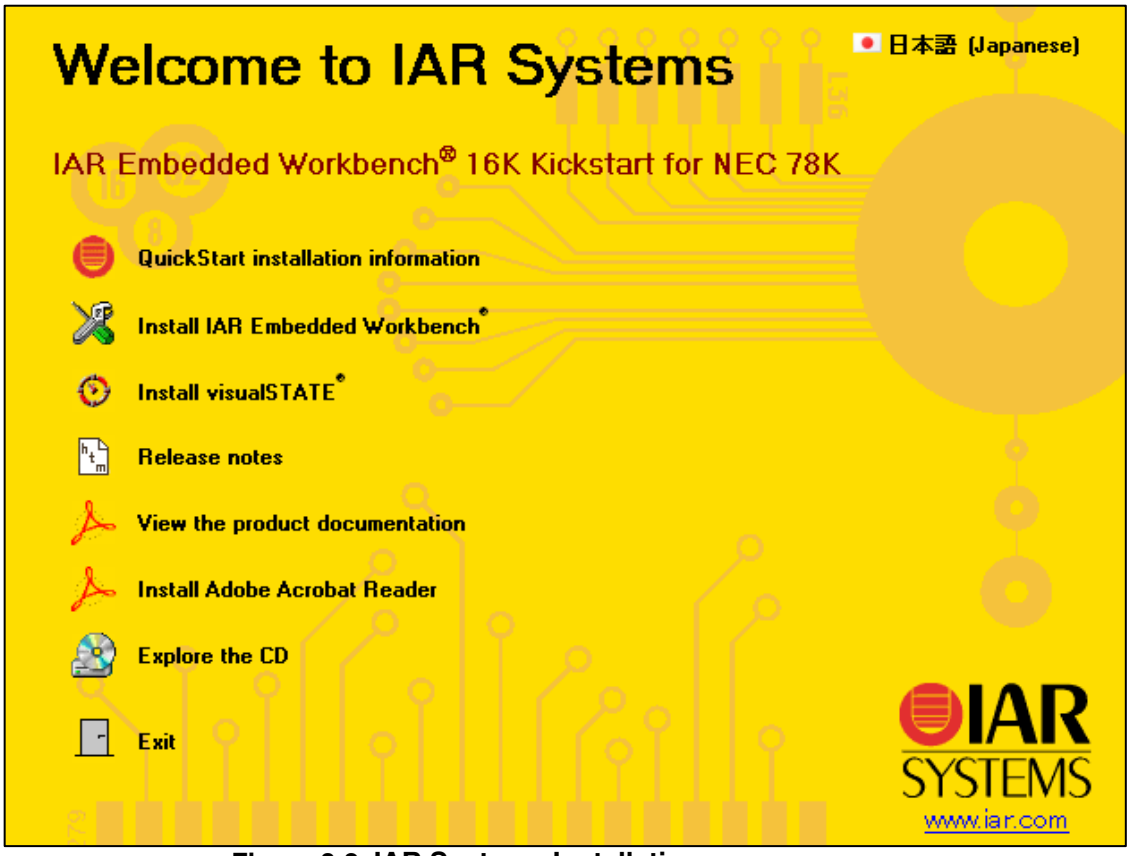


Figure 8-2. IAR Systems Installation screen

To install the IAR Embedded Workbench for 78K just press the regarding button "Install IAR Embedded Workbench ®". The setup dialogues will guide you through the installation process. For further information about the IAR Embedded Workbench installation refer to the `InstallationGuide.ENU.pdf` in the directory"`\IAR Systems\doc\common\doc`" of the CD-ROM.

Notes **Please make sure to install the 78K0R/Kx3-L device file package for the IAR Embedded Workbench, as explained thereafter, before using the IAR Embedded Workbench with the 78K0R–Link It! board.**

8.2 IAR Systems visualSTATE Installation

To install the IAR Systems visualSTATE press the regarding button from the Autorun of the CD-ROM provided within the *78K0R–Link It!* package. The installation can also be started by executing the `Autorun.exe` program in the directory"`\IAR Systems\`" of the CD-ROM. The IAR Systems Installation screen will appear and the installation of IAR visualSTATE can be started by pressing the "Install visualSTATE ®" button. The setup dialogues will guide you through the installation process. For further information about the IAR visualSTATE installation refer to the "`InstallationGuide.pdf`" in the directory"`\IAR Systems\vs78k`" of the CD-ROM.

8.3 Device file package of 78K0R/Kx3-L for IAR Embedded Workbench installation

To install the device file package of the 78K0R/Kx3-L for the IAR Embedded Workbench, press the "Additional software" button from the Autorun of the CD-ROM provided within the *78K0R–Link It!* package. The setup dialogues will guide you through the installation process. The installation can also be started by executing the `EW78K_setup_78K0R-Kx3-L_V1.11.exe` in the directory"`\Device file package`" of the CD-ROM.

8.4 WriteEZ4 installation

To install the WriteEZ4 just press the "Additional software" button from the Autorun of the CD-ROM provided within the *78K0R–Link It!* package. The setup dialogues will guide you through the installation process. The installation can also be started by executing the `WriteEZ4_V102_EE.exe` in the directory"`\WRITEEZ4`" of the CD-ROM.

1. Create a sub-directory PRM in the WriteEZ4 install directory. <WriteEZ4.EXE-install-path>\PRM
2. Copy the parameter file into the sub-directory <WriteEZ4.EXE-install-path>\PRM created during GUI software setup

The regarding 78F1009.prm file can be found on the CD-ROM in the folder "CD-ROM\WRITEEZ4\PRM files"

8.5 *78K0R–Link It!* Sample program installation

To install the sample/demonstration programs for the *78K0R-Link it!* board, press the "78K0R LINK IT Demonstration Program" button from the Autorun of the CD-ROM provided within the *78K0R–Link It!* package. The setup dialogues will guide you through the installation process. The installation can also be started by executing "`78K0R-LINKIT SamplePrograms V1.10.exe`" in the directory" `\SamplePrograms`" of the CD-ROM.

By defaults the sample programs are installed in the following path:

C:\Program Files\NEC Electronics Tools\78K0R-Link It! SamplePrograms

Two sample programs are provided:

Link_It!_Temp_demo.

This program demonstrates a temprearure sensor application. For more details please refer to **Chapter 12 IO-Link Temperature sensor sample.**

Link_It!_Qucick Start

This project is an empty project, where the IO-link stack is already integrated. This project can be used as an example to start an application.

8.6 XML Device Description file installation

To install the XML Device Description file for the *78K0R-Link it!* board, press the "Additional software" button from the Autorun of the CD-ROM provided within the *78K0R–Link It!* package. The setup dialogues will guide you through the installation process. The installation can also be started by executing "`Link-it XML Device Description file V1.10.exe`" in the directory"`\ Link-it XML Device Description file`" of the CD-ROM.

By defaults the sample programs are installed in the following path: C:\Program Files\TMG

8.7 USB Driver Installation

In order to use the 78K0R-Link *It!* board, the USB driver needs to be installed on the host machine. Install the driver according to the following procedure:

Installation on Windows 2000 Page 35

Installation on Windows XP Page 39

8.7.1 Installation on Windows 2000

1. When the *78K0R-Link It!* board is connected with the host machine, the board is recognized by <Plug and Play>, and the wizard for finding new hardware is started. Click Next>.

Found New Hardware Wizard
Welcome to the Found New Hardware Wizard
This wizard helps you install a device driver for a hardware device.
Click.
To continue, click Next.
< Back
Next >
Cancel

Figure 8-3. Found New Hardware Wizard (Windows 2000)

2. Following the window below is displayed. So, check that "Search for a suitable driver ..." is selected, then click Next>

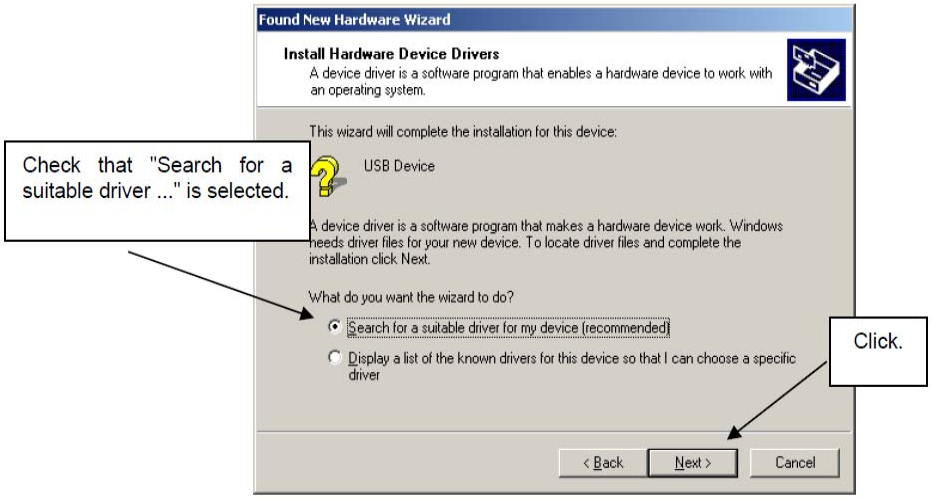

Found New Hardware Wizard
Install Hardware Device Drivers
A device driver is a software program that enables a hardware device to work with an operating system.
This wizard will complete the installation for this device:
USB Device
A device driver is a software program that makes a hardware device work. Windows needs driver files for your new device. To locate driver files and complete the installation click Next.
What do you want the wizard to do?
Search for a suitable driver for my device (recommended)
Display a list of the known drivers for this device so that I can choose a specific driver
Check that "Search for a suitable driver ..." is selected.
Click.
< Back
Next >
Cancel

Figure 8-4. Search Method (Windows 2000)

3. Check the "Specify a location" check box only, then click Next>.

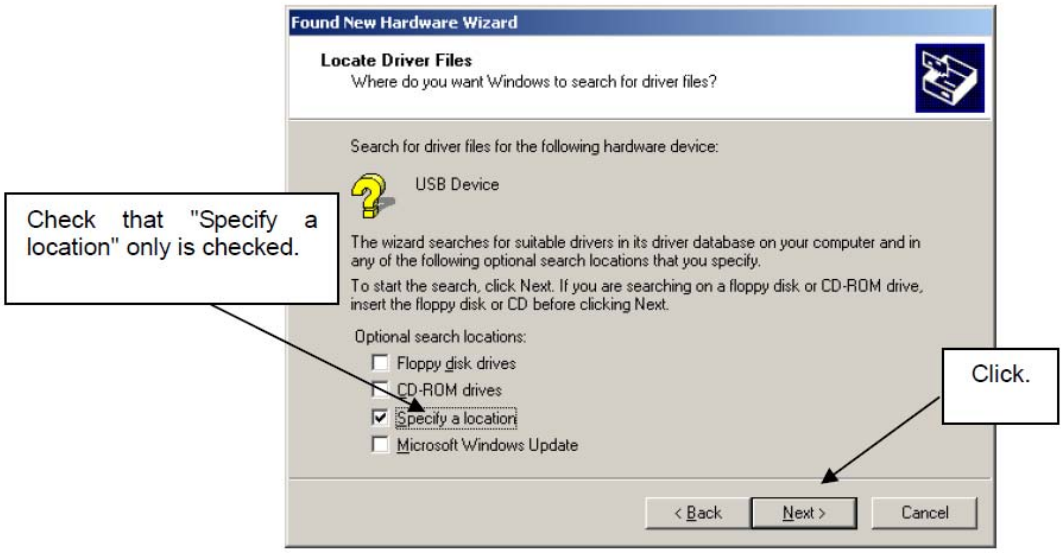

Found New Hardware Wizard
Locate Driver Files
Where do you want Windows to search for driver files?
Search for driver files for the following hardware device:
USB Device
The wizard searches for suitable drivers in its driver database on your computer and in any of the following optional search locations that you specify.
To start the search, click Next. If you are searching on a floppy disk or CD-ROM drive, insert the floppy disk or CD before clicking Next.
Optional search locations:
Floppy disk drives
CD-ROM drives
Specify a location
Microsoft Windows Update
< Back
Next >
Cancel
Check that "Specify a location" only is checked.
Click.

Figure 8-5. Driver File Location (Windows 2000)

4. Locate to the folder "CD-ROM:\Driver".

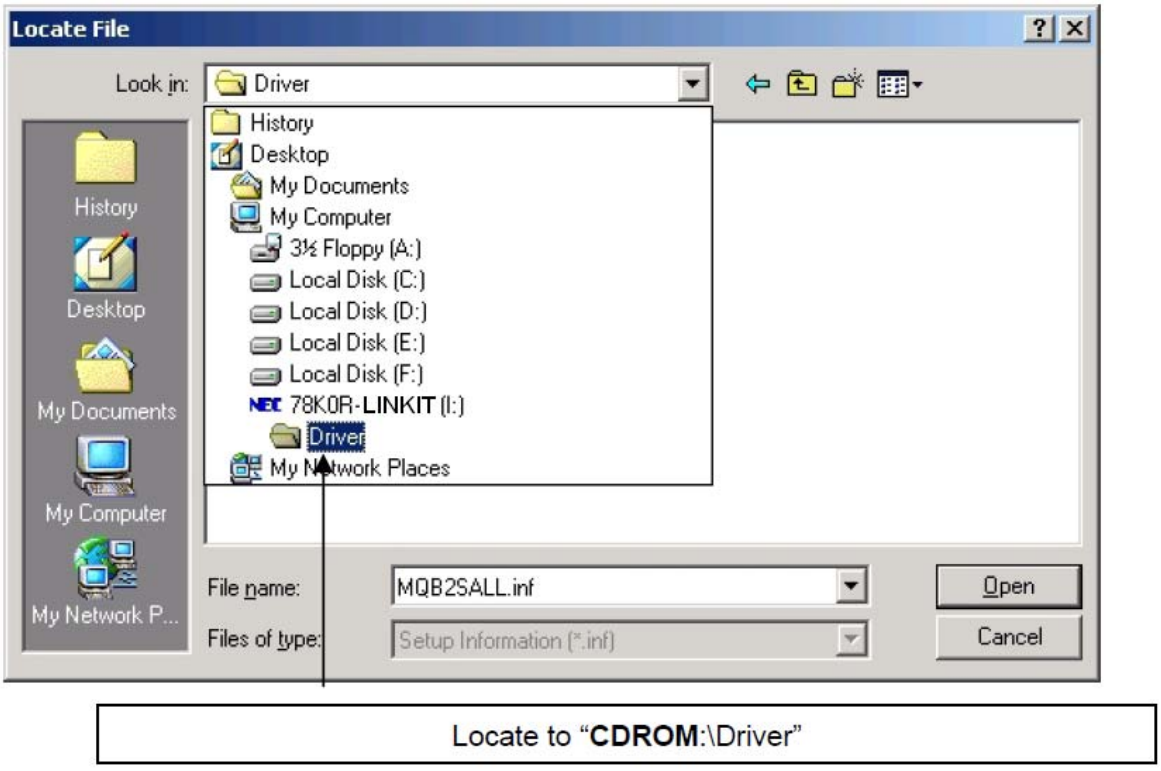


Figure 8-6. Address Specification 1 (Windows 2000)

5. The setup information file “MQB2ALL.inf” is automatic selected, then click Open to proceed within driver installation.

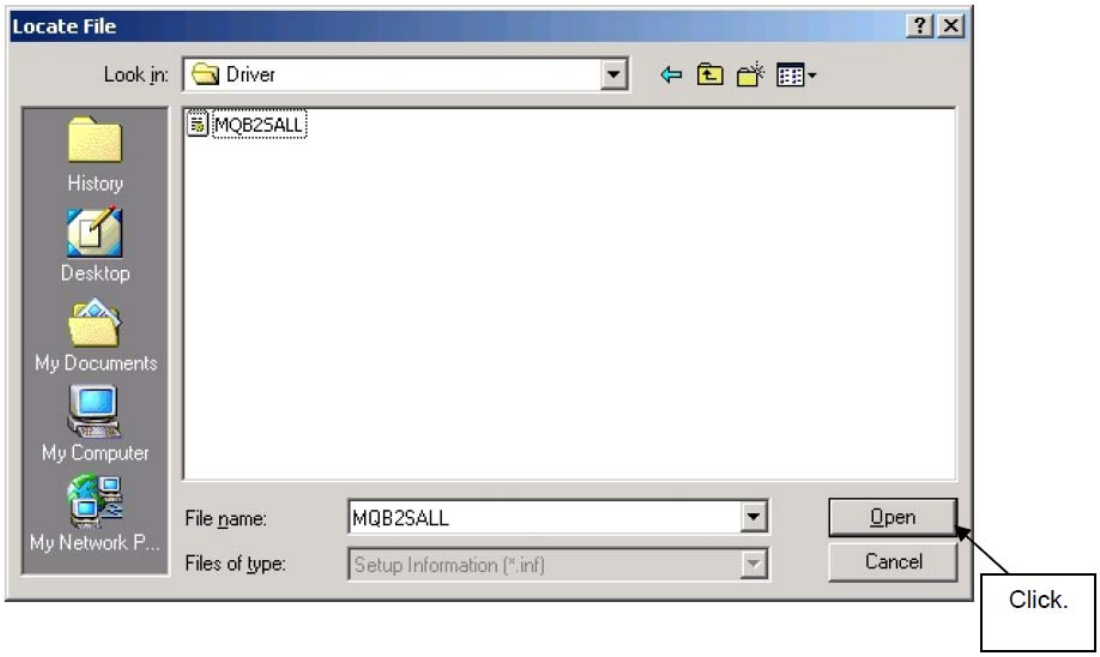


Figure 8-7. Address Specification 2 (Windows 2000)

6. After the location of the USB driver has been specified click OK to proceed.

Figure 8-8. Address Specification 3 (Windows 2000)

7. Click Next>.

Found New Hardware Wizard
Driver Files Search Results
The wizard has finished searching for driver files for your hardware device.
The wizard found a driver for the following device:
USB Device
Windows found a driver for this device. To install the driver Windows found, click Next.
NEC
i:\driver\mqb2sall.inf
Click
< Back
Next >
Cancel

Figure 8-9. Driver File Search (Windows 2000)

8. Click Finish to complete the installation of the USB driver.

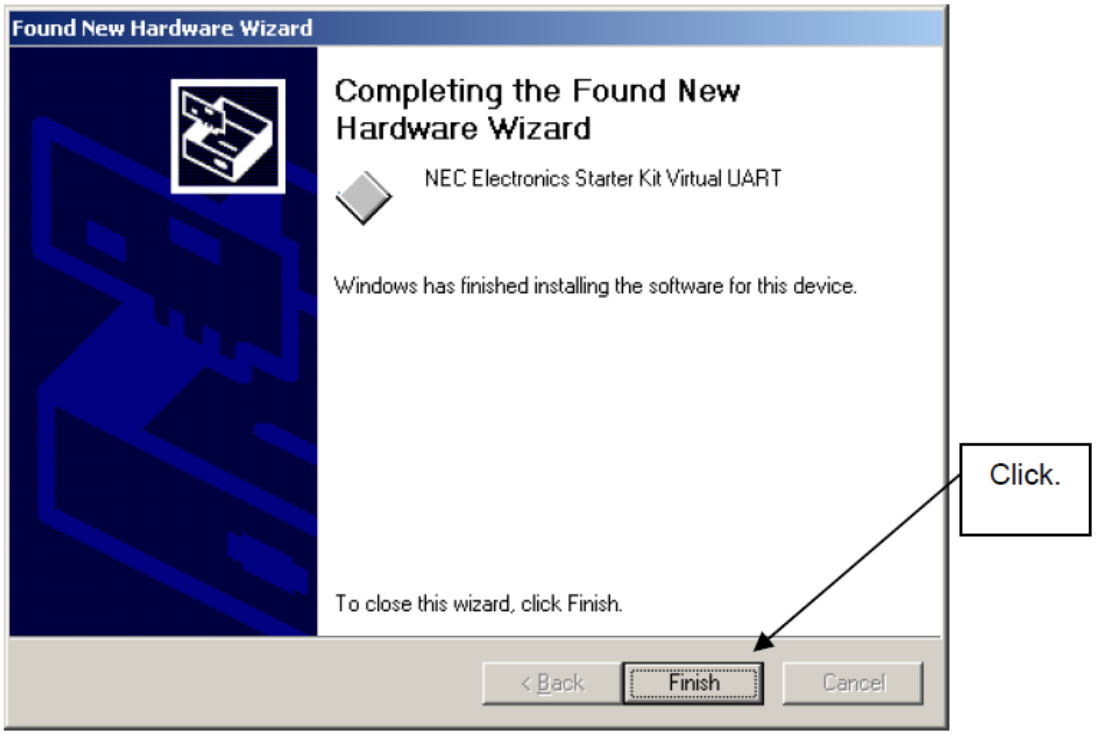

Found New Hardware Wizard
Completing the Found New Hardware Wizard
NEC Electronics Starter Kit Virtual UART
Windows has finished installing the software for this device.
To close this wizard, click Finish.
Click.
< Back
Finish
Cancel

Figure 8-10. USB Driver Installation Completion (Windows 2000)

8.7.2 Installation on Windows XP

1. When the *78K0R-Link-It!* board is connected with the host machine, the board is recognized by Plug and Play, and the wizard for finding new hardware is started. At first the hardware wizard will ask if windows should search on the windows update web, check "No, not this time" and then click Next>

   The *78K0R-Link-It!* board is connected with the host machine, the board is recognized by <Plug and Play>, and the wizard for finding new hardware is started. Click Next>.

Found New Hardware Wizard
Welcome to the Found New Hardware Wizard
Windows will search for current and updated software by looking on your computer, on the hardware installation CD, or on the Windows Update Web site (with your permission).
Read our privacy policy
Can Windows connect to Windows Update to search for software?
Yes, this time only
Yes, now and every time I connect a device
No, not this time
Click Next to continue.
< Back
Next >
Cancel
Check that "No, not this time" is selected.
Click.

Figure 8-11. Found New Hardware Wizard 1 (Windows XP)

2. Check that "Install from a list or specific location (Advanced)" is selected, then click Next>.

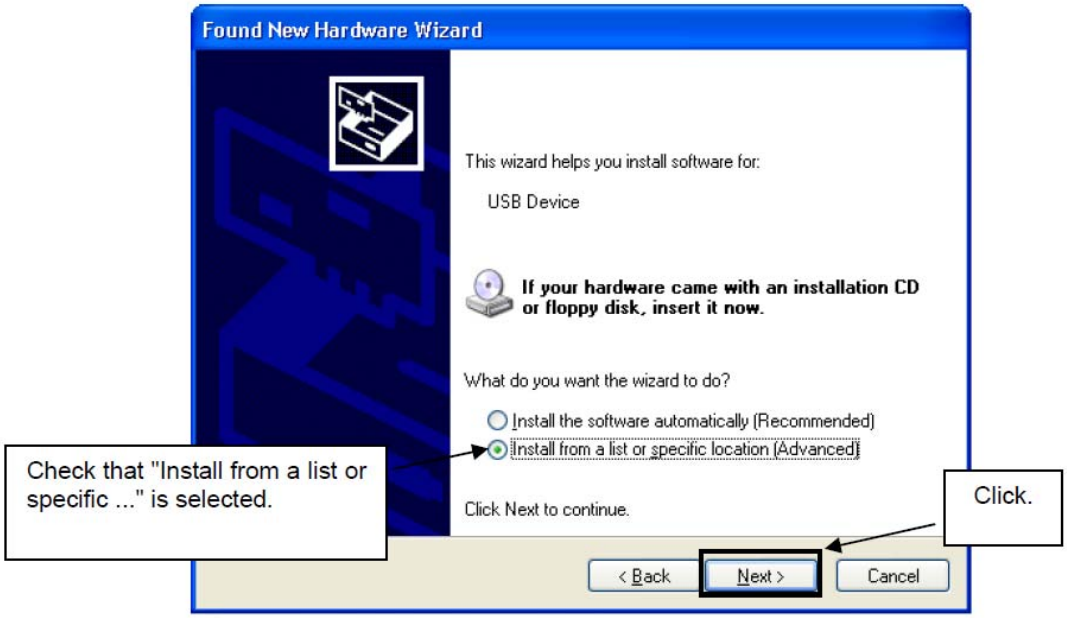

Found New Hardware Wizard
This wizard helps you install software for:
USB Device
If your hardware came with an installation CD or floppy disk, insert it now.
What do you want the wizard to do?
Install the software automatically (Recommended)
Install from a list or specific location (Advanced)
Click Next to continue.
< Back
Next >
Cancel
Check that "Install from a list or specific ..." is selected.
Click.

Figure 8-12. Found New Hardware Wizard 2 (Windows XP)

3. Check that "Search for the best driver in these locations." is selected. Select the "Include this location in the search:" check box and then click Browse.

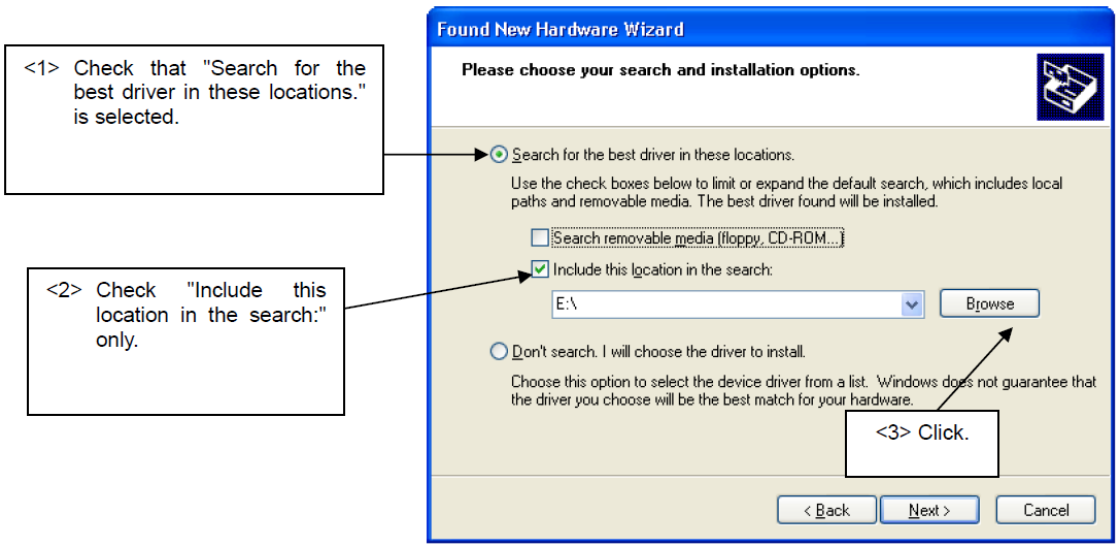

<1> Check that "Search for the best driver in these locations." is selected.
<2> Check "Include this location in the search:" only.
Found New Hardware Wizard
Please choose your search and installation options.
Search for the best driver in these locations.
Use the check boxes below to limit or expand the default search, which includes local paths and removable media. The best driver found will be installed.
Search removable media (floppy, CD-ROM...)
Include this location in the search:
E:\
Browse
Don't search. I will choose the driver to install.
Choose this option to select the device driver from a list. Windows does not guarantee that the driver you choose will be the best match for your hardware.
<3> Click.
< Back
Next >
Cancel

Figure 8-13. Search Location Specification 1 (Windows XP)

4. Locate the folder "C **CD-ROM**:\Driver" and click OK.

Figure 8-14. Search Location Specification 2 (Windows XP)

5. As shown below, "NEC Electronics Starter Kit Virtual UART has not passed Windows Logo testing to verify its compatibility with Windows XP." is displayed. Click Continue Anyway.

Hardware Installation
The software you are installing for this hardware:
NEC Electronics Starter Kit Virtual UART
has not passed Windows Logo testing to verify its compatibility with Windows XP. (Tell me why this testing is important.)
Continuing your installation of this software may impair or destabilize the correct operation of your system either immediately or in the future. Microsoft strongly recommends that you stop this installation now and contact the hardware vendor for software that has passed Windows Logo testing.
Click.
Continue Anyway
STOP Installation

Figure 8-15. Windows XP Logo Testing (Windows XP)

6. After the installation of the USB driver is completed the window below is displayed. Click Finish to close the hardware wizard.

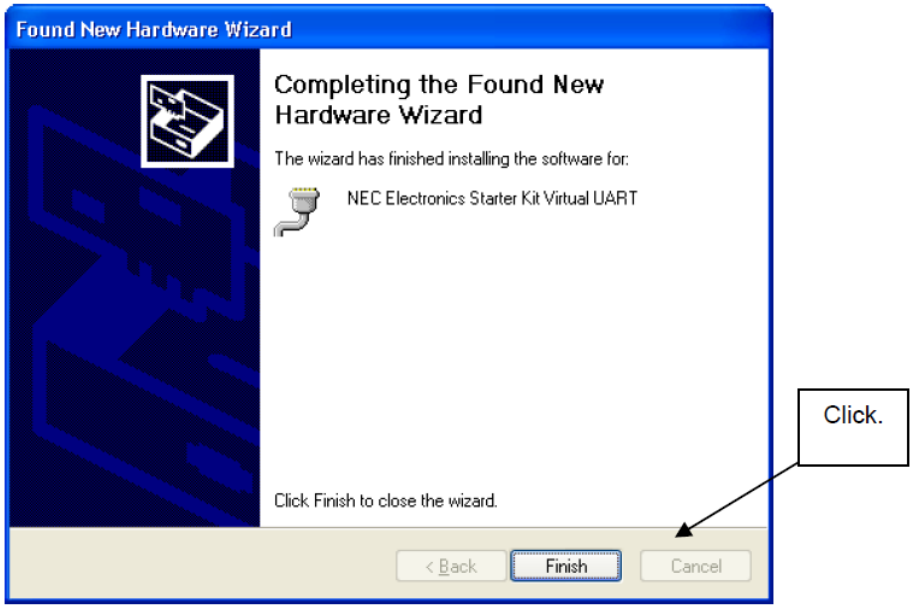


Figure 8-16. USB Driver Installation Completion (Windows XP)

8.8 Confirmation of USB Driver Installation

After installing the USB driver, check that the driver has been installed normally, according to the procedure below. When using the Save It! board the “NEC Electronics Starter Kit Virtual UART” should be present like in the figure below.

Please check in the Windows "Device Manager" within the Windows Properties (“Hardware” tab), that the driver is installed normally.

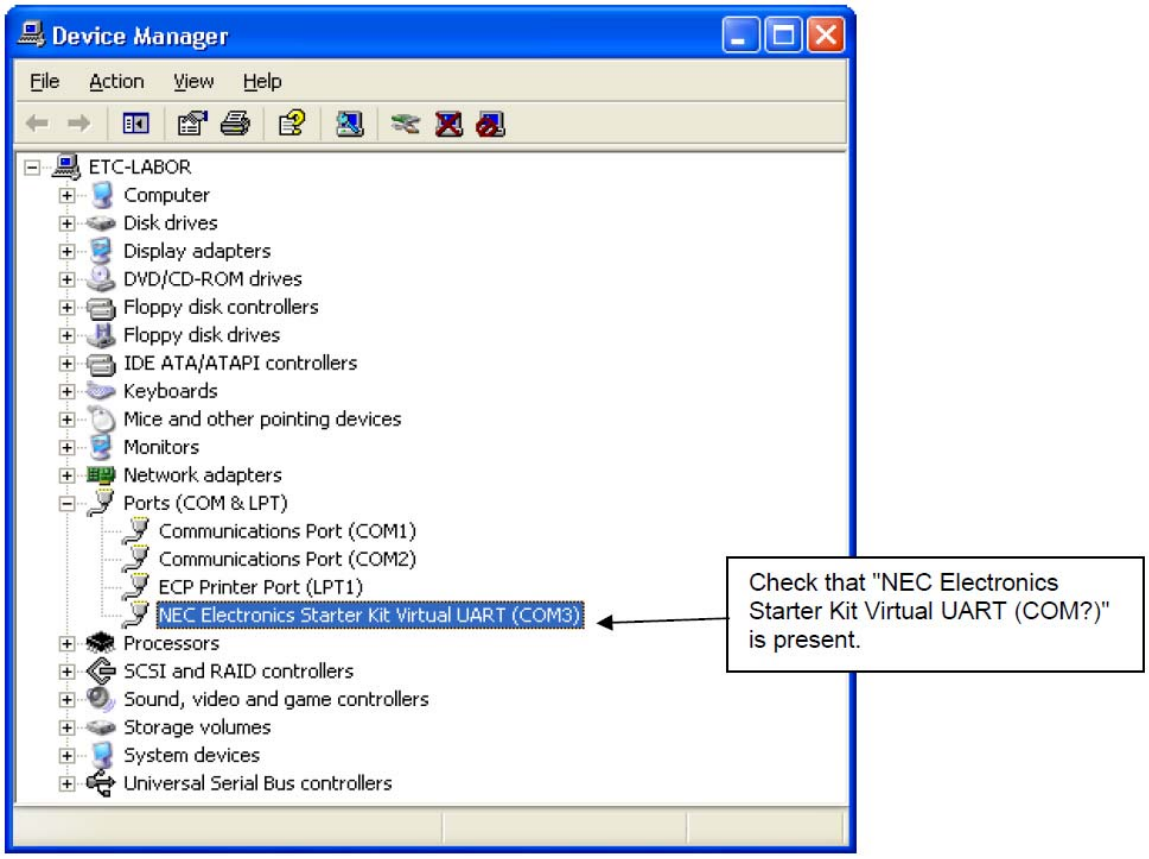


Figure 8-17. Windows Device Manager

CHAPTER 9 FLASH PROGRAMMER WRITEEZ4

WriteEZ4 is a flash programming software to flash hex files to the related device. For installation information refer to the **chapter 8.4.WriteEZ4 installation.**

9.1 Starting up the GUI Software

GUI software startup

Select WriteEZ4.EXE from the start menu to start the WriteEZ4 GUI software.
When the GUI software is started normally, the following screen appears.

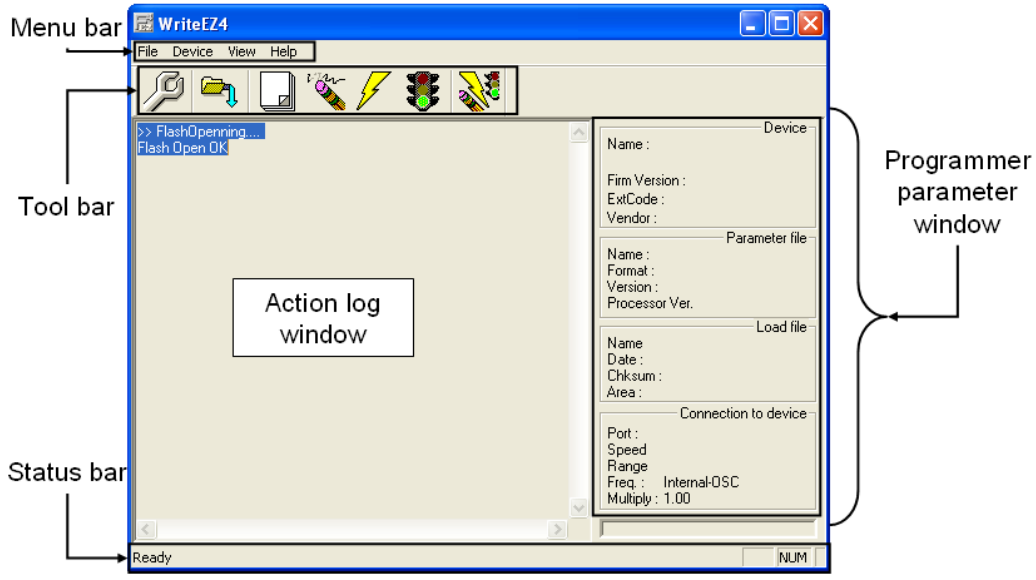


Figure 9-1. WriteEZ4 Startup

This window consists of the following items:

Table 9-1. WriteEZ4 Windows items

Name	Display Information
Menu bar (displayed at the top)	Displays menu items executable by the WriteEZ4
Toolbar. (displayed under the menu bar)	Displays frequently used commands as icons.
Action log window (displayed under the toolbar)	Displays an WriteEZ4 action log
Programmer parameter window (Displayed to the right of the action log window).	Displays programming parameter settings.
Status bar	Displays status..

9.2 Toolbar

The toolbar contains buttons for starting the important procedures of the WriteEZ4.

Table 9-2. Toolbar Buttons

	[Device] → [Setup] button
	[File] → [Load] button
	[Device] → [Blank Check] button
	[Device] → [Erase] button
	[Device] → [Program] button
	[Device] → [Verify] button
	[Device] → [Auto procedure(EPV)] button

9.3 Menu Bar

Depending on the actual device status and device type, some menu items may be enabled or disabled.

9.3.1 [File] menu

Clicking the [File] menu displays the pull-down menu as shown below. This menu mainly contains commands related to file operation.

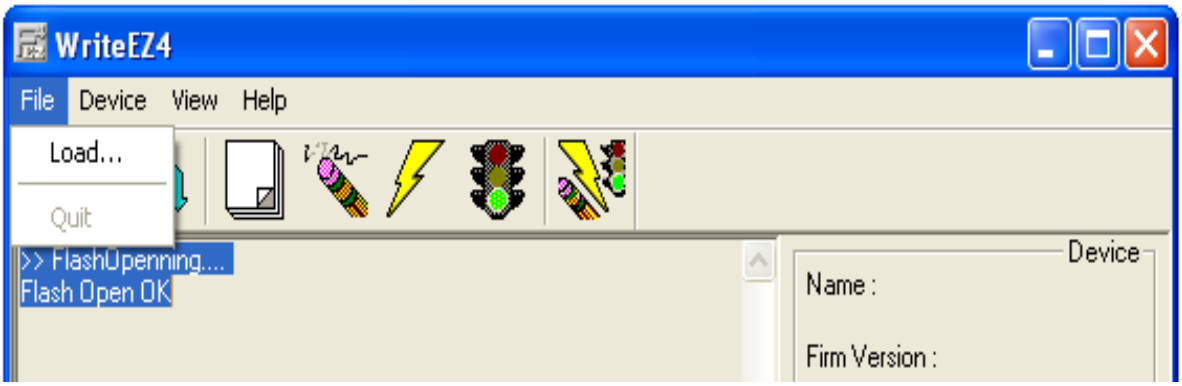


Figure 9-2. [File] menu

9.3.1.1 [Load] command

The [Load] command allows you to select a program file. The selected program file is programmed into the flash memory of the device by executing the [Program] command or [Autoprocedure (EPV)] command.

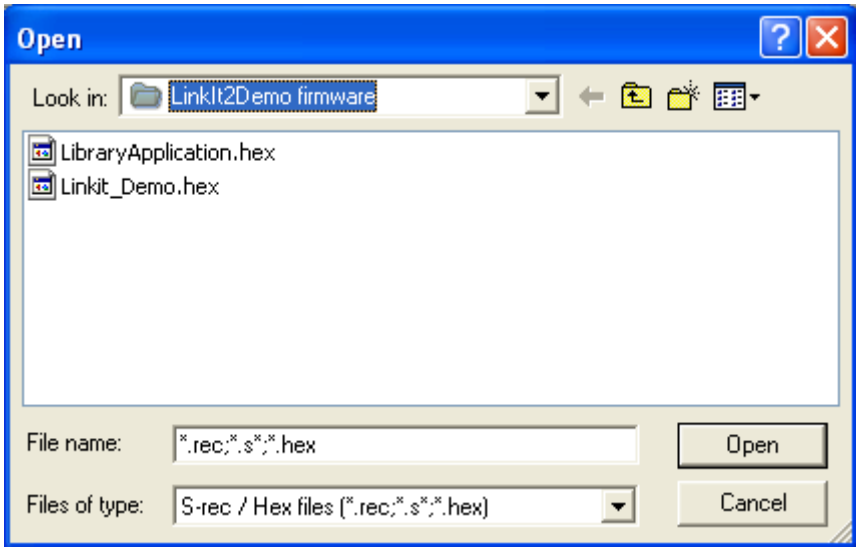


Figure 9-3. HEX File Selection Window

The file selection window for program loading displays the most recently used directory to which a user program has been loaded. After a user program is loaded, a checksum calculation is made and the result is displayed in the programmer parameter window.

[Open button], selects a user program as a program to be written to the target device.

[Cancel button], closes the window without selecting a program.

9.3.1.2 [Quit] command

The [Quit] menu is the command for terminating the WriteEZ4 GUI software. Clicking the [×] box on the top right side of the task bar also terminates the WriteEZ4 GUI software.

User settings are saved in the WriteEZ4.INI file, so that the GUI software starts up next time with the same settings.

Notes **WriteEZ4.INI is created in the Windows folder when Windows XP is used.**

When Windows 2000 is used, WriteEZ4.INI is created in the Winnt folder

.

9.3.2 [Device] menu

Clicking the [Device] menu displays the pull-down menu as shown below. This menu mainly contains commands for programming operations such as deletion, programming, and verification on the target device.

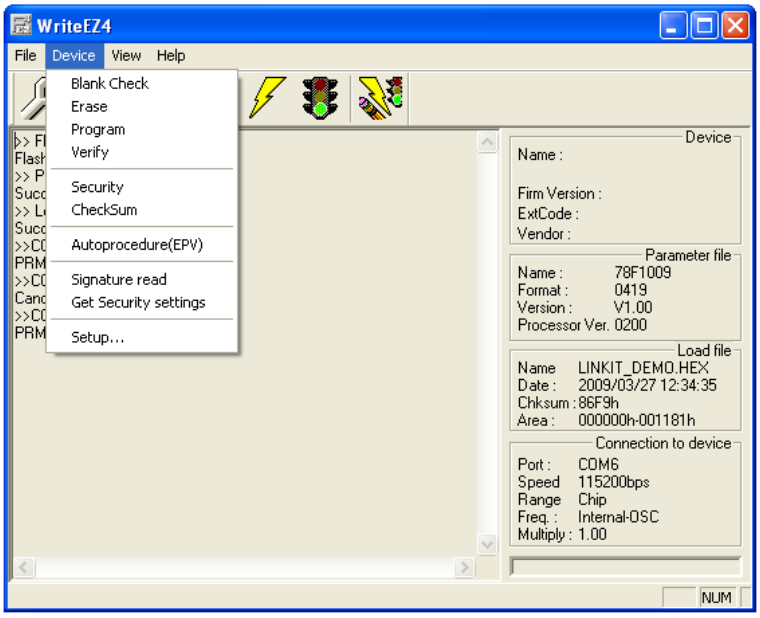


Figure 9-4. [Device] menu

9.3.2.1 [Blank Check] command

The [Blank Check] command allows you to make a blank check on the target device connected to the WriteEZ4. If the flash memory of the target device is erased, a blank check is terminated normally. If the flash memory is not completely erased, the indication "not blank" is provided. Before starting programming, erase the flash memory of the target device.

9.3.2.2 [Erase] command

The [Erase] command erases the flash memory of the target device connected to the WriteEZ4. While the flash memory is being erased, the progress status is displayed in the action log window to indicate programmer operation. The execution on the [Blank Check] command before the [Erase] command is executed follows the setting of 'Command options' of the Advance tab displayed by selecting [Device] → [Setup].

Upon completion of [Erase] command execution, the GUI software displays the result of executing the command on the target device.

9.3.2.3 [Program] command

The [Program] command sends a specified user program to the target device and writes the program to the flash memory. The execution of Verify operation for detecting an error in user program communication from the WriteEZ4 to the target device after the execution of the [Program] command follows the setting of the 'Command options' on the Advance tab displayed by selecting [Device] → [Setup].

During programming, the progress status is displayed in the action log window to indicate programmer operation. This progress status display window displays the progress status on target device programming by percentage.

Upon completion of [Program] command execution, the GUI software displays the result of executing the command on the target device.

9.3.2.4 [Verify] command

The [Verify] command sends a specified user program to the target device connected with the WriteEZ4, and performs verification against the data written to the flash memory of the target device. During verification, the progress status is displayed in the action log window to indicate programmer operation. This progress status display window displays the progress status of target device verification by percentage.

Upon completion of [Verify] command execution, the GUI software displays the result of executing the command on the target device.

9.3.2.5 [Security] command

The [Security] command initiates the programming of the security flag of the target device connected to the WriteEZ4. Set ‘Security flag settings’ on the Advance tab of the [Device] >

[Setup] menu.

9.3.2.6 [Checksum] command

The [Checksum] command reads the checksum value of the target device connected with the WriteEZ4.

This value differs from the value displayed in the parameter window of the main window.

9.3.2.7 [Autoprocedure (EPV)] command

The [Autoprocedure (EPV)] command executes the [Erase] command, [Program] command and [Verify] command in succession. When a user program is to be resent to the target device for comparison with the data written to the flash memory of the target device because of a user program communication error, execute the [Program] command by selecting [Device] →

[Setup] and specifying 'Command options' on the Advance tab, then set the automatic execution of the [Verify] command.

During EPV execution, the progress status is displayed in the action log window to indicate programmer operation. For a selected command, its execution operation, and messages, refer to Chapter 10.

Upon completion of [Autoprocedure (EPV)] command execution, the GUI software displays the result of executing the command on the target device.

9.3.2.8 [Signature read] command

The [Signature read] command reads the signature information (device name, flash memory information, and so forth) of the target.

9.3.3 [Setup] command

The [Setup] menu allows you to make settings related to flash memory rewriting according to the user environment and to set command options. Each time the GUI software is started, the most recently used parameter file (.PRM) is read and the settings are displayed. The [Setup] menu allows you to modify the settings of items other than those items consisting of shadowed characters according to the user environment.

9.3.3.1 Standard setup

This menu is used to set the environment for rewriting the flash memory of the target device.

The mode of communication with the target, the operating clock, and so forth differ depending on the device used. For details, refer to the manual of the device used, when making settings.

The window shown below is opened.

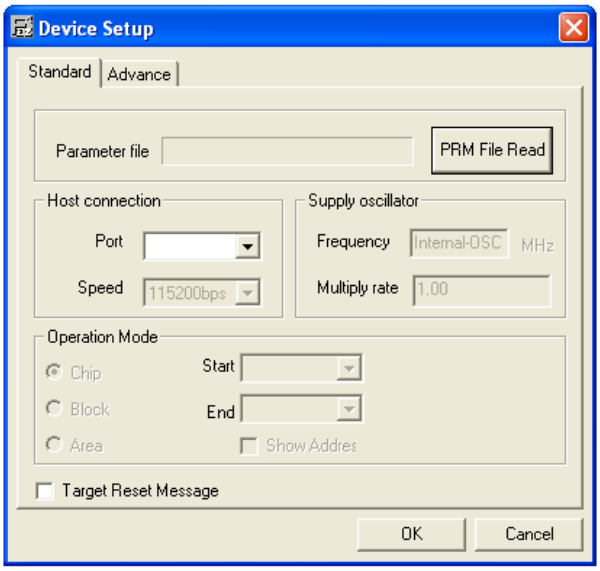


Figure 9-5. Device Setup Window - Standard

This window shows all basic options that can be set in accordance with the user environment and target device.

[OK button]: Clicking the OK button saves the settings on the Standard and Advance menus and closes the window.

[Cancel button]: Clicking the Cancel button closes the window without saving the settings on the Standard and Advance menus.

9.3.3.1.1 Parameter file

This file holds parameters and timing data required to rewrite the flash memory of the target device. Do not modify the data in the parameter file because the data is related to the guarantee of rewrite data.

The parameter file is protected by the checksum function. If the checksum result indicates an error, the WriteEZ4 does not accept the parameter file.

Figure 9-6. Device Setup Window - Parameter File Selection

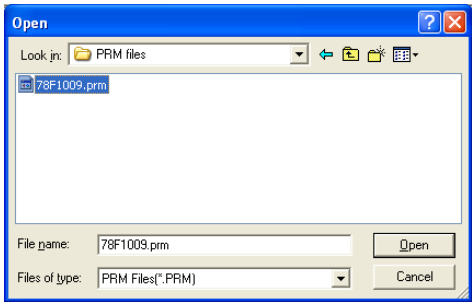


Figure 9-7. Parameter File Selection Window

[PRM File Read button]: A window for specifying a parameter file is displayed. Specify a desired file then click Open.

9.3.3.1.2 Host connection

"Host connection" is used to select a channel for communication between the *78K0R–Link It!* board and host machine.

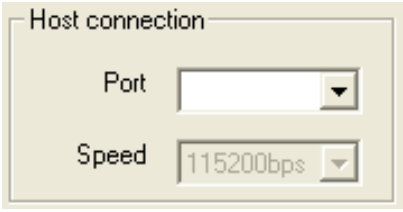


Figure 9-8. Device Setup Window – Host connection

[Port list box]

Select a channel for communication between the *78K0R–Link It!* board and host machine.

- COM1 to COM256

Remark Selectable ports can be checked using Device Manager. For details, refer to CHAPTER **8.8Confirmation of USB Driver Installation**

[Speed list box]

Select a communication rate for the selected communication channel from the following:

- 9600 bps
- 19200 bps
- 38400 bps
- 115200 bps

Remark For selectable communication rates, refer to the user's manual of the device used.

9.3.3.1.3 Supply oscillator

"Supply oscillator" is used to select a clock that determines programming, data transfer, and a transfer rate.

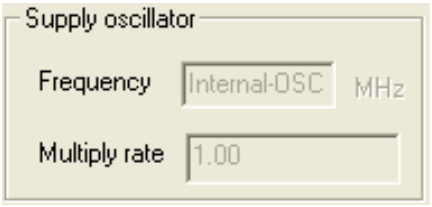


Figure 9-9. Device Setup Window - Supply Oscillator Selection

[Frequency box]

Sets the clock frequency of the target system. The range of operating frequency varies from one device to another. So, check the specifications of the device used before making a setting.

[Multiply rate]

Specifies the division rate or multiplication rate of the target device. If the target device has an on-chip PLL circuit, enter a division rate or multiplication rate according to the use environment. The selectable division rate or multiplication rate differs depending on the device.

Check the specifications of the device used before making a setting.

If the target device does not have an on-chip PLL circuit, select "1.0".

On the initial screen, the default setting is displayed according to the parameter file.

9.3.3.1.4 Operation Mode

The setting of "Operation Mode" may divide the flash memory of some target devices into blocks or areas.

This menu is used to select an operation mode of the flash memory. Some devices do not have the block and area division modes, and some devices have only one of the modes. In these cases, a nonexistent mode is not selectable.

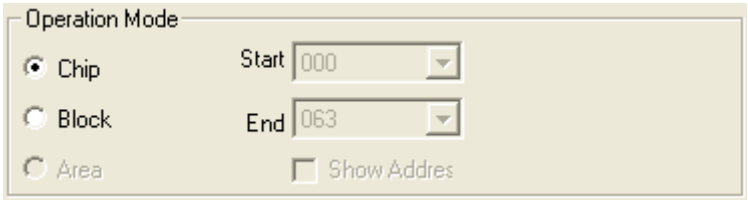


Figure 9-10. Device Setup Window - Operation Mode

[When Chip is selected]

The entire flash memory area of the target device is subject to rewrite processing.

[When Block is selected]

Specify the Block number range subject to rewrite processing by using Start/End.

The Start/End list boxes display the Block numbers where the flash memory of the

target device is configured.

[When Area is selected]

Specify the Area number range subject to rewrite processing by using Start/End.

The Start/End list boxes display the Area numbers where the flash memory of the

target device is configured.

[Show Address check box]

Specify whether numbers or addresses are displayed in the Start/End list boxes.

If this check box is checked, addresses are displayed.

If this check box is not checked, numbers are displayed.

9.3.3.1.5 Target Reset Message

By checking the Target Reset Message check box, the window promoting the reset operation manually is displayed even when the reset signal cannot be connected to the target cable.

Figure 9-11. Device Setup Window – Target Reset Message

9.3.3.2 Advance setup

The Advance setup menu is used to specify the command options and security flag settings.

When "Advance" is clicked, the following window is displayed:

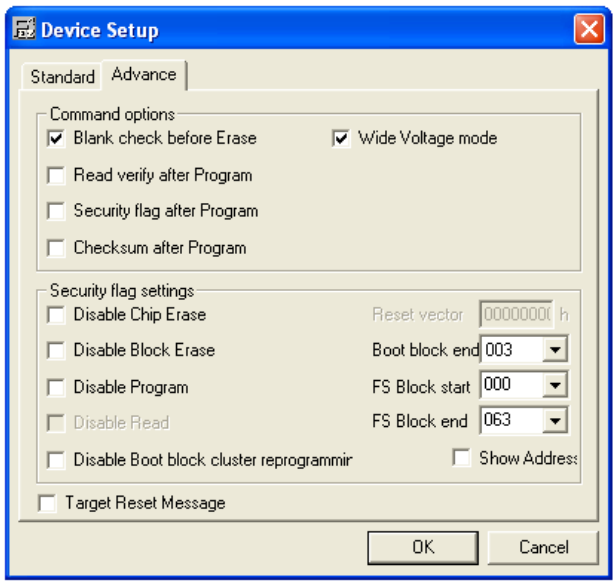


Figure 9-12. Device Setup Window – Advance

9.3.3.2.1 Command options

This dialog box is used to specify the WriteEZ4 flash processing command options.

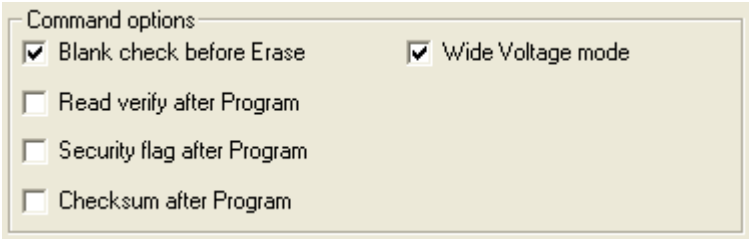


Figure 9-13. Device Setup Window - Command options

[Blank check before Erase check box]

If this check box is checked, blank check is made before the Erase command or EPV command is executed.

If the result of a blank check indicates OK, erase processing is not executed.

[Read verify after Program check box]

If this check box is checked, write data is sent from the programmer after execution of the Program command and EPV command, then the data is verified against the data written to the flash memory.

[Security flag after Program check box]

If this check box is checked, automatic programming of the selected security flag is executed after execution of the [Program] and [Autoprocedure (EPV)] commands.

[Checksum after Program check box]

If this check box is checked, the flash memory checksum value of the target device is read from the target device after execution of the Program command and EPV command.

This value differs from the value displayed in the parameter window of the main window.

9.3.3.2.2 Security flag settings

The <Security flag settings> dialog box is used to specify which security function is valid.

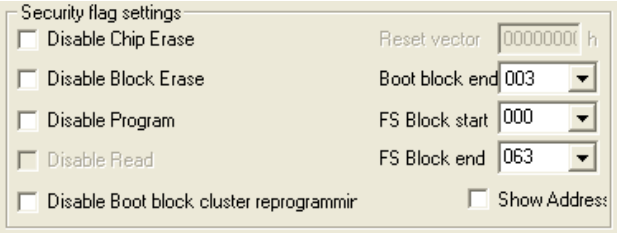


Figure 9-14. Device Setup Window – Security flag settings

Caution The following table is the correspondence between the [Erase] and [Program] Commands when the security functions of a 78K0R/KE3-L microcontroller are valid!

	Chip Erase Command	Block Erase Command	Program Command
Disable Chip Erase	Invalid	Invalid	Valid (Note1)
Disable Block Erase	Valid	Invalid	Valid
Disable Program	Valid	Invalid	Invalid
Disable Boot block cluster reprogramming	Invalid	Valid (Note2)	Valid (Note2)

Notes

1. **Since the [Erase] command is invalid, the data that differs from the data already written in the flash memory cannot be written.**
2. **Valid only for the area other than the area specified as the boot area**

[Disable Chip Erase check box]

If this check box is checked, the [Erase] command becomes invalid in the entire flash memory area of the target device.

At this time, the warning message shown below is displayed.

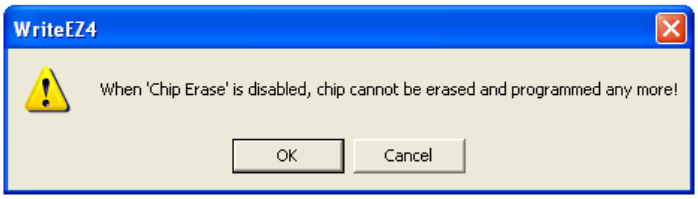


Figure 9-15. Device Setup Window – Disable Chip Erase

Caution **Be aware that if the security flag is set in the target device, neither erasing nor writing** to **the device can be enabled afterward!!!**

[Disable Block Erase check box]

If this check box is checked, the [Erase] command becomes invalid in all the blocks of the flash memory selected under Operation Mode in the Standard Setup menu. This setting is cleared by the [Erase] command when Chip was selected under Operation Mode.

[Disable Program check box]

If this check box is checked, the [Program] command becomes invalid, as does the [Erase] command in all the blocks of the flash memory selected under Operation Mode in the Standard Setup menu.

The [Erase] command for the entire flash memory area is valid. This setting is cleared by the [Erase] command when Chip was selected under the Operation Mode.

[Disable Boot block cluster reprogramming check box]

If this check box is checked, the boot area is set with the boot block set in the Boot block Cluster setting as the last block. At this time, the warning message shown below is displayed.

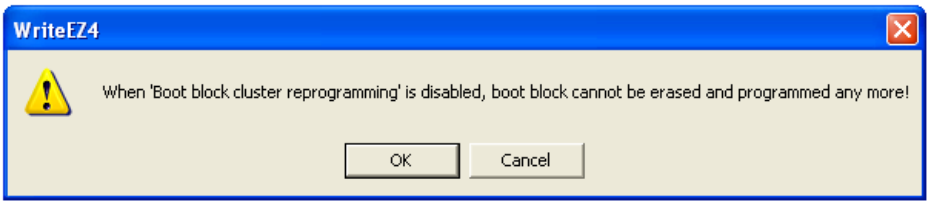

WriteEZ4
When 'Boot block cluster reprogramming' is disabled, boot block cannot be erased and programmed any more!
OK
Cancel

Figure 9-16. Device Setup Window – Disable Boot Cluster Reprogramming warning

Caution **Be aware that if the security flag is set in the target device, the boot area cannot be rewritten to the device afterward!!!**

9.3.4 [View] menu

Clicking the [View] menu displays the pull-down menu shown below.

This menu contains commands for setting whether to display the toolbar and status bar.

Figure 9-17. [View] Menu

9.3.4.1 [Toolbar] command

Checking the [Toolbar] command displays the toolbar. Unchecking the command hides the toolbar.

9.3.4.2 [Status Bar] command

Checking the [Status Bar] command displays the status bar. Unchecking the command hides the status bar.

9.3.5 [Help] menu

Clicking the [Help] menu displays the following pull-down menu:

Figure 9-18. [Help] Menu

9.3.5.1 [About WriteEZ4] command

The [About WriteEZ4] command opens the program entry window as shown below and indicates the version.

Clicking OK terminates the display.

Figure 9-19. About WriteEZ4 Window

9.4 Programmer Parameter Window

This window displays the settings of the programming parameters.

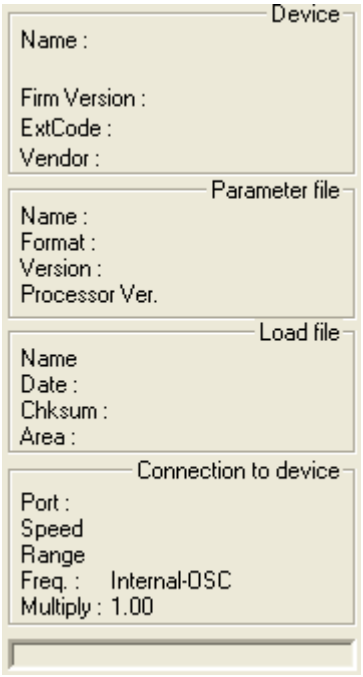


Figure 9-20. Programmer Parameter Window

[Device]

Updated after communication with the target device to display information about the target device.

[Parameter file]

Updated after [Setup] command execution to display information about a read parameter file.

[Load file]

Updated after [Load] command execution to select information about a selected program file.

[Connection to device]

Updated after [Setup] command execution to display information about the connection with the target device.

CHAPTER 10 HOW TO USE WRITEEZ4 FLASH PROGRAMMING SOFTWARE

This chapter explains the basic operation of the WriteEZ4 GUI for programming the *78K0R-Link it!* board. It covers how to start the system, execute the EPV command, and program the target device. Furthermore, the FLASH programming of the 78K0R/KE3-L via WriteEZ4 is shown in the following pages.

The conditions of the series of operations described in this chapter are as follows:

Hardware configuration of *78K0R-Link it!*:

Base board: *78K0R-Link it!*

Target device: 78K0R/KE3-L (μ PD78F1009)

Clock: Internal Oscillator

Voltage level: 5 V

Software configuration of WriteEZ4:

Parameter file: 78F1009.PRM

Clock setting: Internal Oscillator

Port: COM6 (115200 bps)

Operation mode: Chip

Write HEX: Linkit_Demo.hex

Option setting: Blank check before Erase

10.1 Installing the WriteEZ4 GUI software

Install the WriteEZ4 GUI software on the host machine you are using, by referring to section 8.4 WriteEZ4 installation (if the software has not been installed yet).

10.2 Installing the driver

Install the USB driver on the host machine you are using, by referring to section 8.7 USB Driver Installation (if the driver has not been installed yet).

10.3 Installing the parameter file

The parameter file (*.prm) for the µPD78F1009 is located on the CD-ROM, in the same folder as the WriteEZ4 setup file.

Nevertheless, newest version of parameter file for the μ PD78F1009 device can by download from the NEC Electronics Web site.

Download the parameter file for the PG-FP4 from the following NEC Electronics Web site:

http://www.eu.necel.com/updates

Copy the parameter file downloaded from the NEC Electronics Web site into sub-directory <WriteEZ4.EXE-install-path>\PRM created during GUI software setup (refer to section **8.4 WriteEZ4 installation**).

10.4 Connecting and starting

Set the *78K0R-Link it!* board to the WriteEZ4 FLASH programming mode by switching SW5, SW7 and jumpers JP1 to JP4 to the following setting:

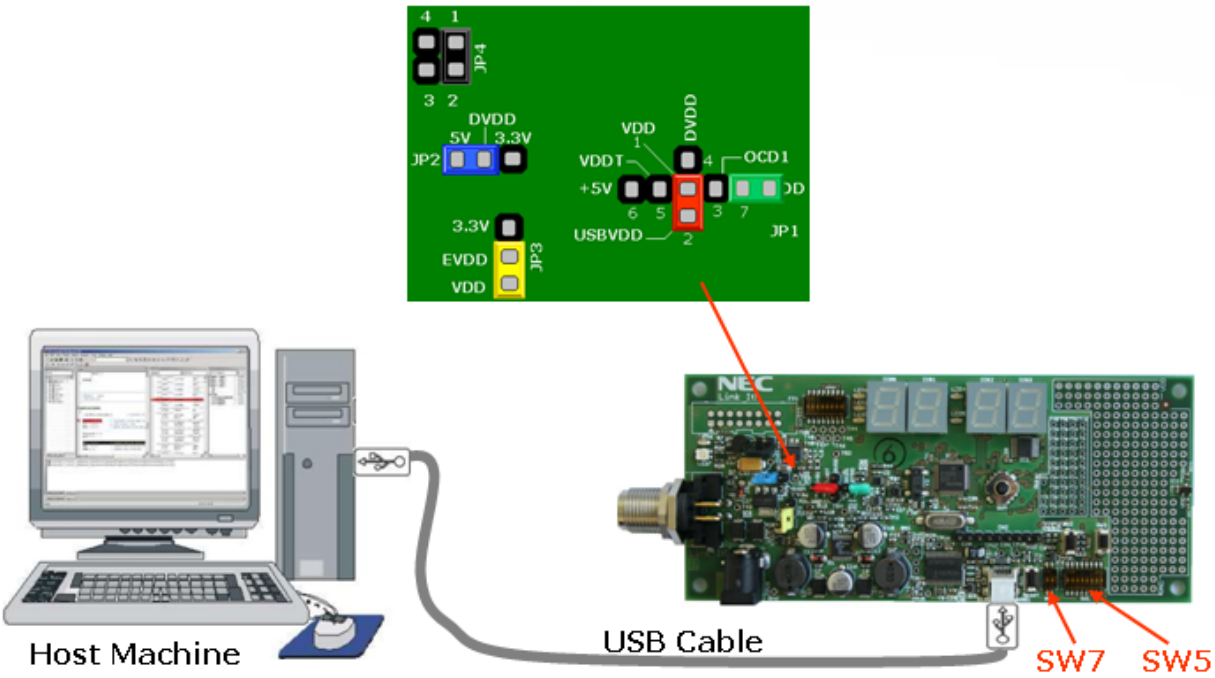


Figure 10-1. WriteEZ4 FLASH programming mode connection

Table 10-1. WriteEZ4 FLASH programming mode

Mode	SW5										SW7	
	1	2	3	4	5	6	7	8	9	10	1	2
WriteEZ4		ON	ON			Don't care			ON	ON	Don't care	ON
	OFF			OFF	OFF							

<Plug and Play> connect the *78K0R-Link it!* board with the host machine via the USB cable.

10.5 Start the WriteEZ4 GUI.

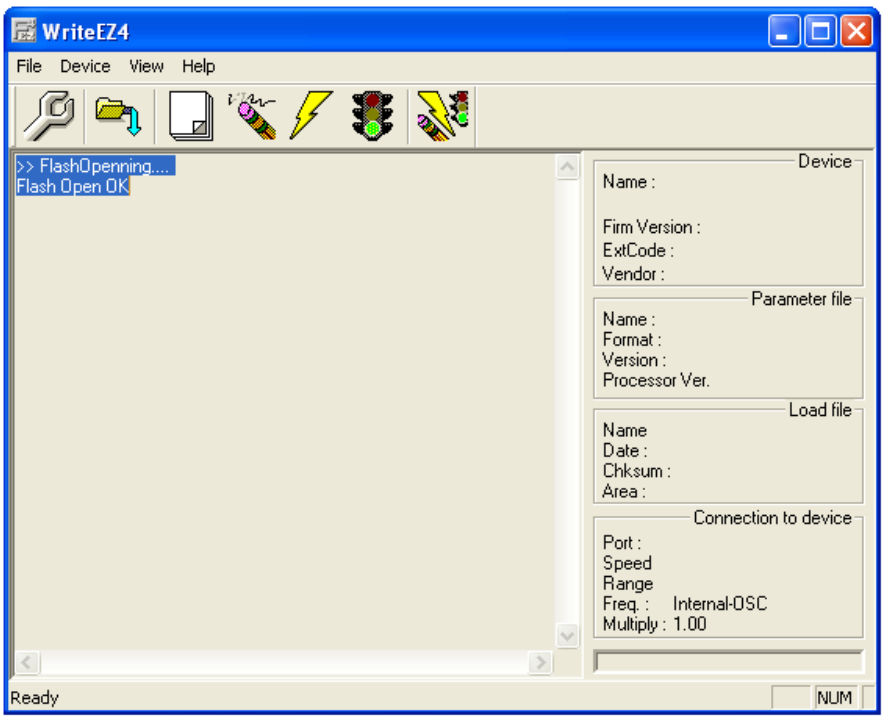


Figure 10-2. GUI Software Startup Screen

10.6 Setting the programming environment

Select [Device] → [Setup] from the menu bar.

The Standard dialog box for device setup is activated.

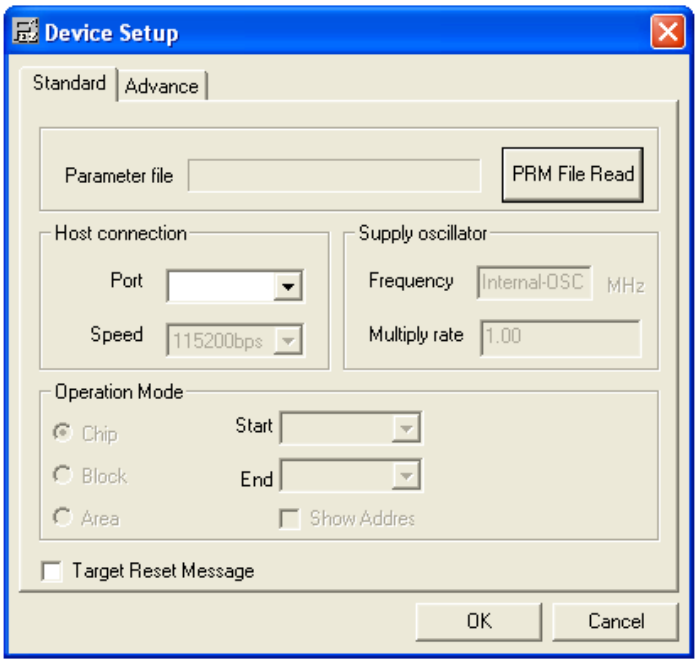


Figure 10-3. <Standard Device Setup> Dialog Box

Click PRM File Read to open the parameter file selection window.

Select the parameter file “78F1009.prm” then click Open.

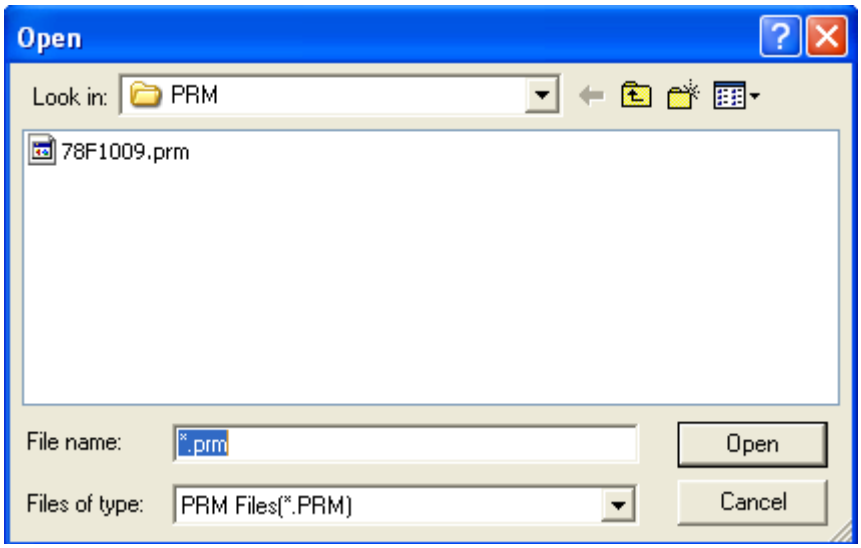


Figure 10-4. Parameter File Selection

From the Port list box, select the communication port that matches the host machine being used. Select the communication speed of the Host connection.

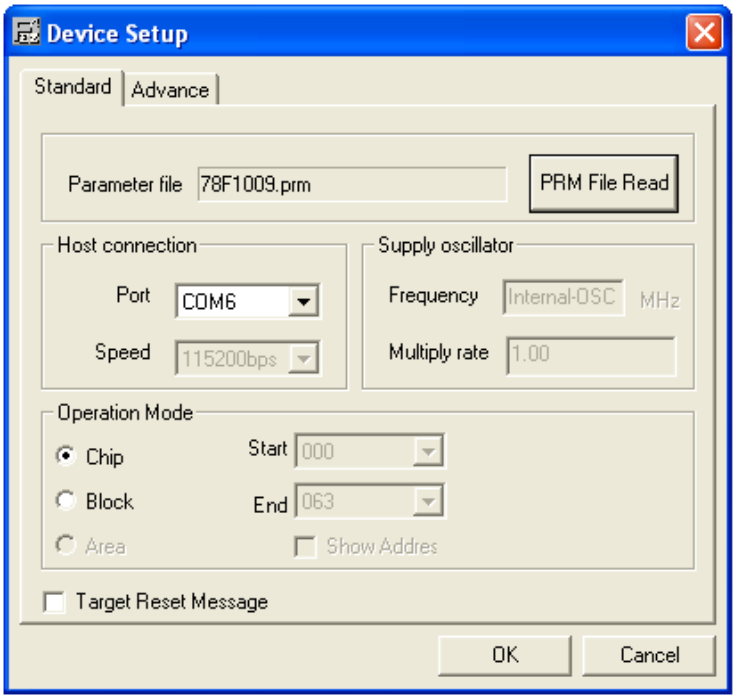


Figure 10-5. Port Selection

Remark Selectable ports can be checked using Device Manager. For details, refer to 8.8 Confirmation of USB Driver Installation.

Click the OK button. The GUI software sets the parameters.
When the settings have been completed, the following screen is displayed:

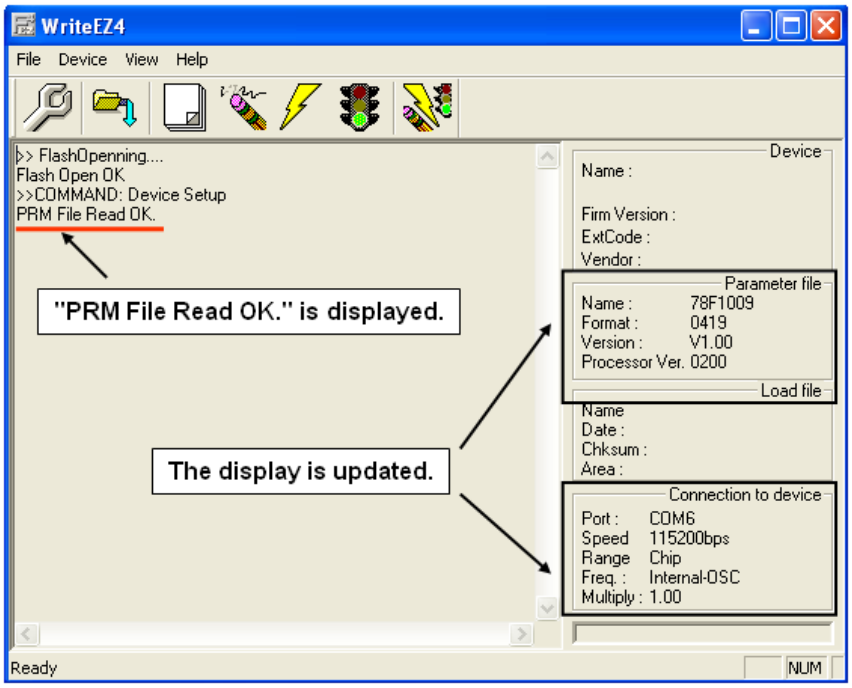


Figure 10-6. Completion of Parameter Setting

10.7 Selecting a user program

Select [File] → [Load].

Select a program file to be written to the target device, then click Open

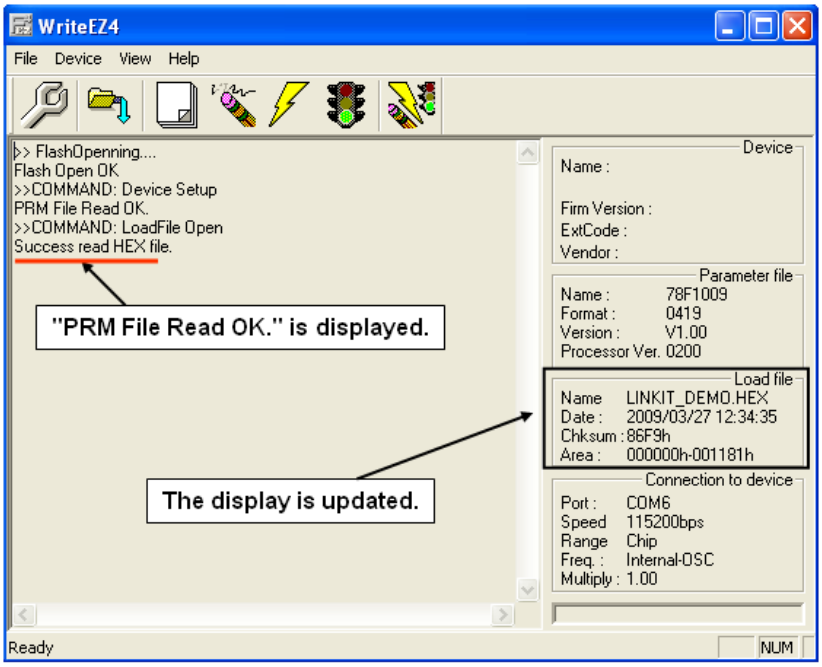


Figure 10-7. After Downloading

10.8 Autoprocedure (EPV)] command execution

Select [Device] → [Autoprocedure (EPV)] from the menu bar.

When the [Autoprocedure (EPV)] command is executed, Blank Check → Erase → Program and FLASH Internal Verify are executed sequentially for the μPD78F1009 device.

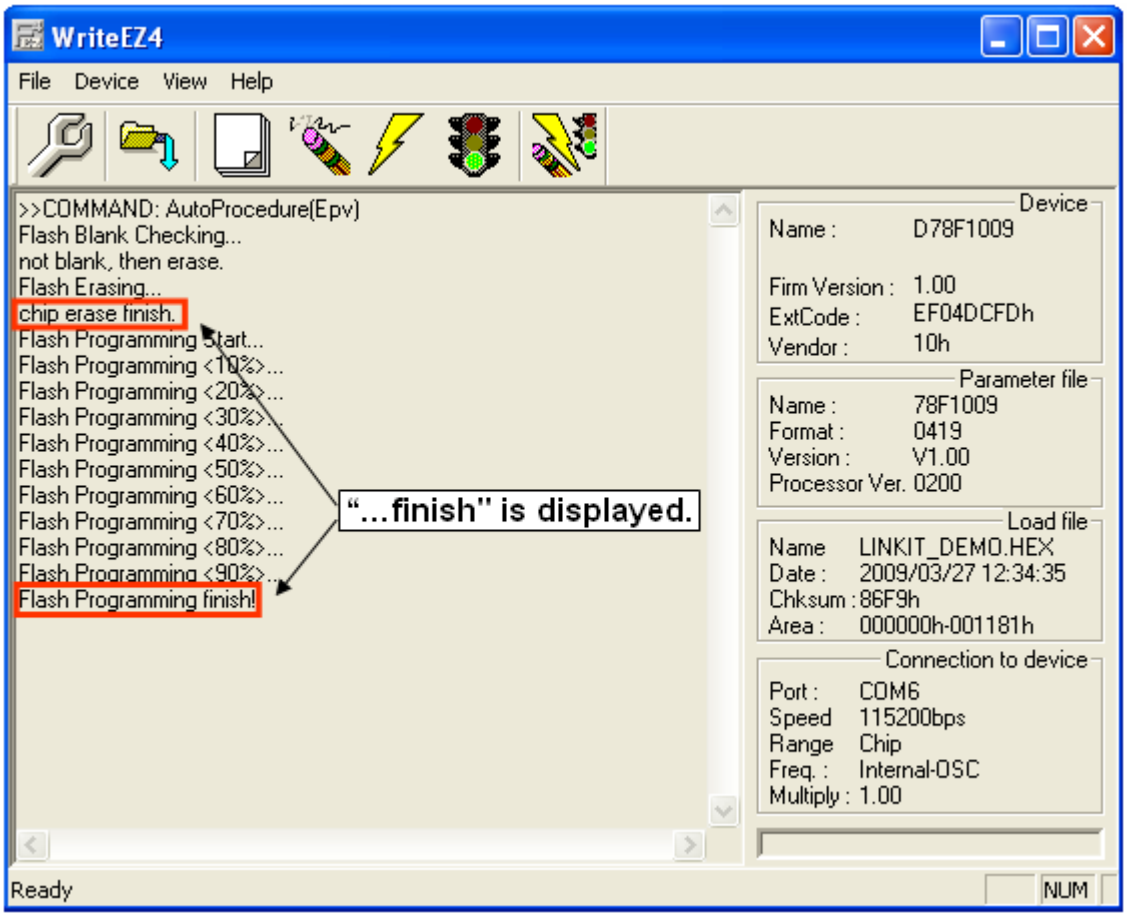


Figure 10-8. After EPV Execution

After flash programming is complete, unplug the USB cable and set SW5, SW7 and the jumpers to their factory settings.

However, if the board must be powered from the USB cable, switch bit 1 of SW5 to 1 to set the board in standalone mode, and press the reset button SW1 to run the application programmed in the microcontroller.

10.9 Terminating the GUI

Select [File] → [Quit] to terminate the GUI software. All settings executed so far are saved in the WriteEZ4.INI file, so that those settings can be reused when the GUI software is restarted.

10.10 Restarting the GUI

When the system is restarted, the same screen as shown in Figure 10-7. After Downloading, appears.

10.11 Erasing the flash memory (using the WriteEZ4)

If a preprogrammed software has been written to the flash it is mandatory to erase the flash of the device before it is possible to use the IAR Embedded Workbench with the *78K0R–Link It!* board. To erase the flash please perform following steps.

Make sure that the *78K0R–Link It!* board is in the Debugging/Writing mode: (section 10.4.Connecting and starting.)

If not already connected, connect the *78K0R–Link It!* board via USB1 connector to the target device.

Run the WriteEZ4 flash programming software.

Select [Device] → [Erase] from the menu bar, or Click the **erase button**

After finishing the flash erase following message shall apply

Figure 10-9. WriteEZ4 flash erase successful

CHAPTER 11 IAR EMBEDDED WORKBENCH *78K0R–LINK IT!* SAMPLE PROJECT

The IAR Embedded Workbench IDE is a very powerful Integrated Development Environment that allows you to develop and manage a complete embedded application project.

The now described project can be found on the *78K0R–Link It!* CD-ROM in the "`\samplePrograms`" folder.

To run/debug the project with the IAR C-SPY debugger it is necessary to follow the steps described below in this chapter.

For further information about the IAR Embedded Workbench ant the included functionalities please refer to the regarding User's manuals available on the *78K0R– Link It!* CD-ROM in the "`\IAR Systems\doc`" folder.

Notes **The *78K0R–Link It!* is shipped with the demo software programmed to the 78K0R/KE3-L's internal memory. Make sure that the Flash memory is erased properly before the first project download to the target device. Refer to section.10.11. Erasing the flash memory (using the WriteEZ4)**.

11.1 Hardware setup

To run the program it is necessary to set up the *78K0R–Link It!* board in the following way:

The communication between the starter kit and the IAR C-SPY debugger running on the host computer is done via the standard UART / USB connection.

To operate the *78K0R-Link it!* board within the TK-78K0R On-Board debug mode, configure switches SW5 to SW7 and Jumpers JP1 to JP4 as instructed in the following figure and Tables:

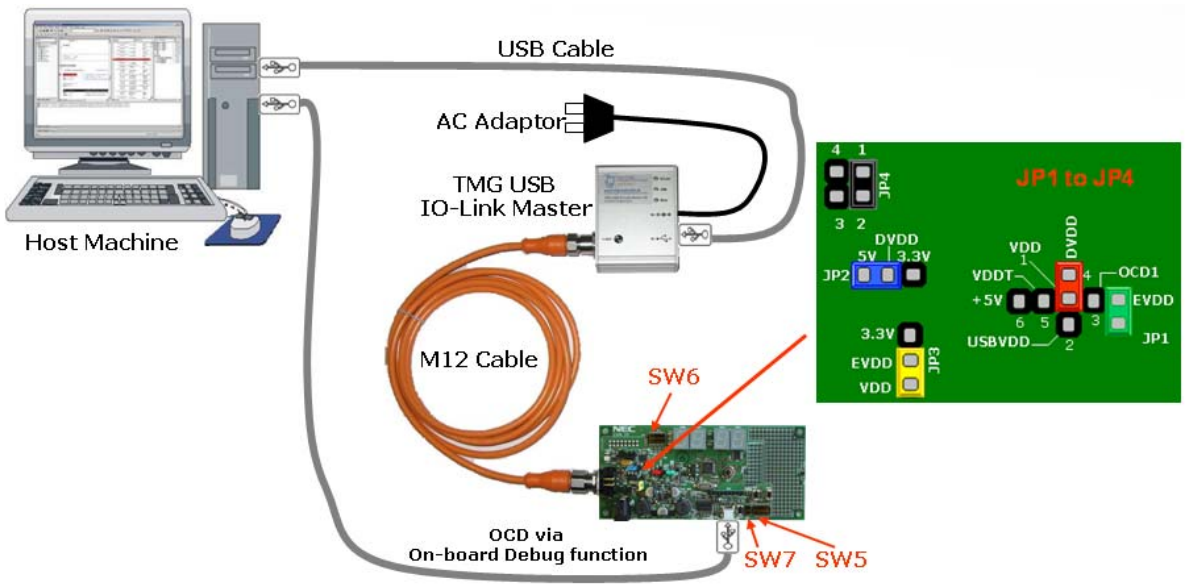


Figure 11-1. IO-Link and On-Chip Debugging via USB

Notes **Figure 11-1 shows the jumper setting when the board is used for an IO-Link application. If you are not using the board for an IO-Link application and USB port power supply is sufficient for your application needs, please use the jumper setting from Figure 10-1 and refer to section 5.2. (OCD via TK-78K0R On-Board debug function) for SW5, SW7 settings**

Table 11-1. SW5 and SW7 setting for On-Chip Debugging via USB

Mode	SW5										SW7	
	1	2	3	4	5	6	7	8	9	10	1	2
TK-78 On-Board debug	ON	ON	ON			ON	ON		ON	ON	ON	ON
				OFF	OFF			OFF				

Table 11-2. SW6 setting for IO-Link Communication

Mode	SW6							
	1	2	3	4	5	6	7	8
Transceiver connected	ON	ON	ON	ON	ON	ON	ON	ON

11.2 Sample Programs

Each of the sample programs is located in a single directory, which will be called main-directory of the sample. This main directory of each sample contains the complete project inclusive all output files of the development tool. The workspace file “78K0R_LINKIT_SAMPLES.eww” is located on top of the sample program directories. All sample programs use the same directory structure:

Table 11-3. Example directory structure

Link_It!_Temp_Demo	78K0R-Link It! project and output files
Application	Application source files
INC	C header files
SRC	C source files
BSP	Board support package (ADC, I2C, Keys)
INC	C header files
SRC	C source files
Debug	debug output files for IAR C-SPY debugger
Release	release output files, i.e. Intel HEX file
settings	configuration files, IAR Embedded Workbench
Stack	IO-Link device stack and header files
Link_It!_Temp_demo.dep	dependency information file, IAR Embedded Workbench
Link_It!_Temp_demo.ewd	project setting file, IAR C-SPY debugger
Link_It!_Temp_demo.ewp	project file, IAR Embedded Workbench
Link_It!_Quickstart	78K0R-Link It! project and output files
78K0R_LINKIT_SAMPLES.eww	workspace file, IAR Embedded Workbench 78K0/78K0S/78K0R

The main directory contains only the project files for the IAR Systems Embedded Workbench 78K0/78K0S/78K0R.

All source files are located in the directories /SRC. The /INC directory contains the header files.

Each sample project uses two targets:

One target is the “Debug” (directory /Debug), which holds all information for debugging purpose.

The other target is the “Release” target (directory /Release), which contains the programmable file, i.e. the Intel HEX file, for programming the 78K0R/KE3-L internal FLASH memory via PG-FP4, PG-FP5, MINICUBE2, or TK-78K0R.

All output files of the development tools for the corresponding target are generated in the directories /Debug and /Release.

11.3 Loading the Link It! sample project

Start the Embedded Workbench from Windows “Start” menu > “Programs” > folder “IAR Systems” > “IAR Embedded Workbench Kickstart for 78K”. The following screen appears:

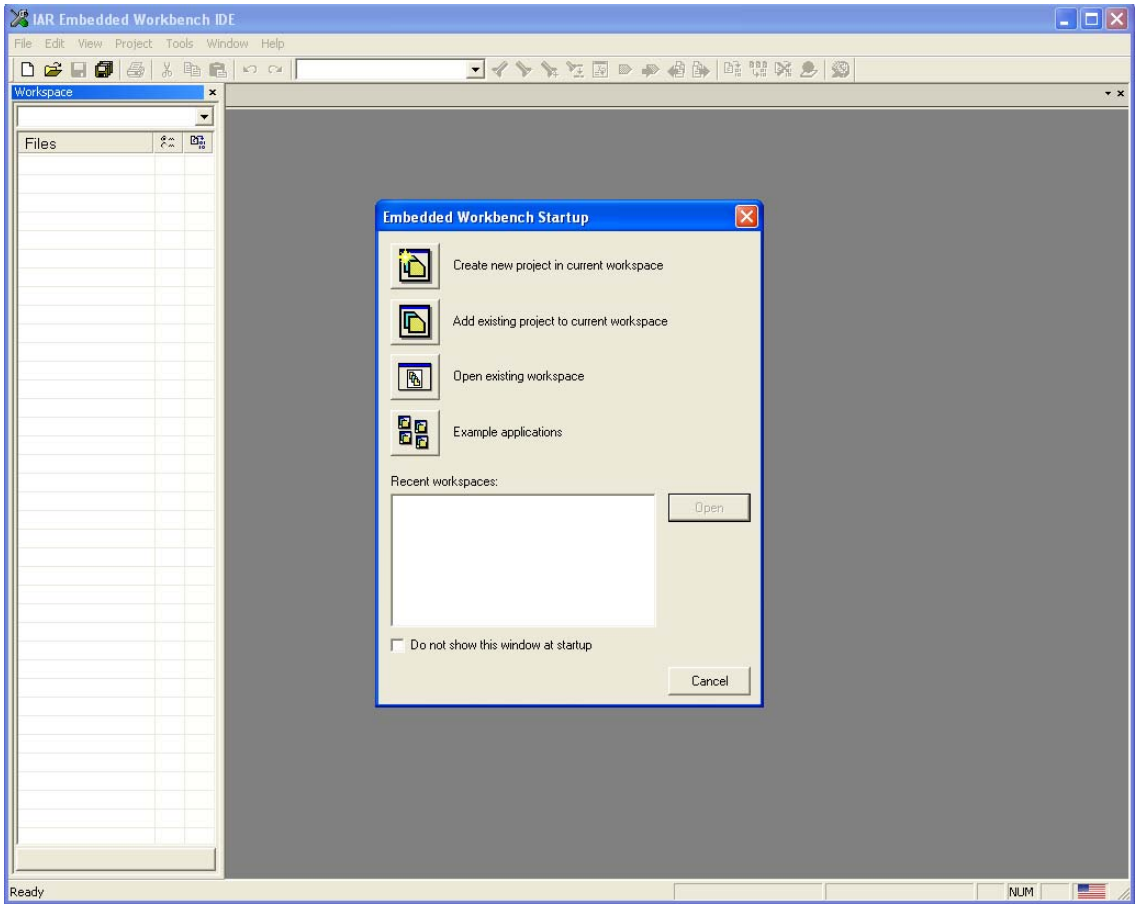


Figure 11-2. IAR Embedded Workbench Startup window

In this window you are able to choose the Open existing workspace button.

Now select the option “Open exiting workspace” from the “File” menu and locate the sample project. Open the 78K0R_LINKIT_SAMPLES.eww workspace file. This is the workspace file that contains general information about the demonstration projects and settings.
After the demo workspace has been opened the projects contained in the workspace are displayed. Click on the little “+” sign next to the “Link_It!_Temp_Demo” project to show files part of the project.

The IDE should look similar too the figure below.

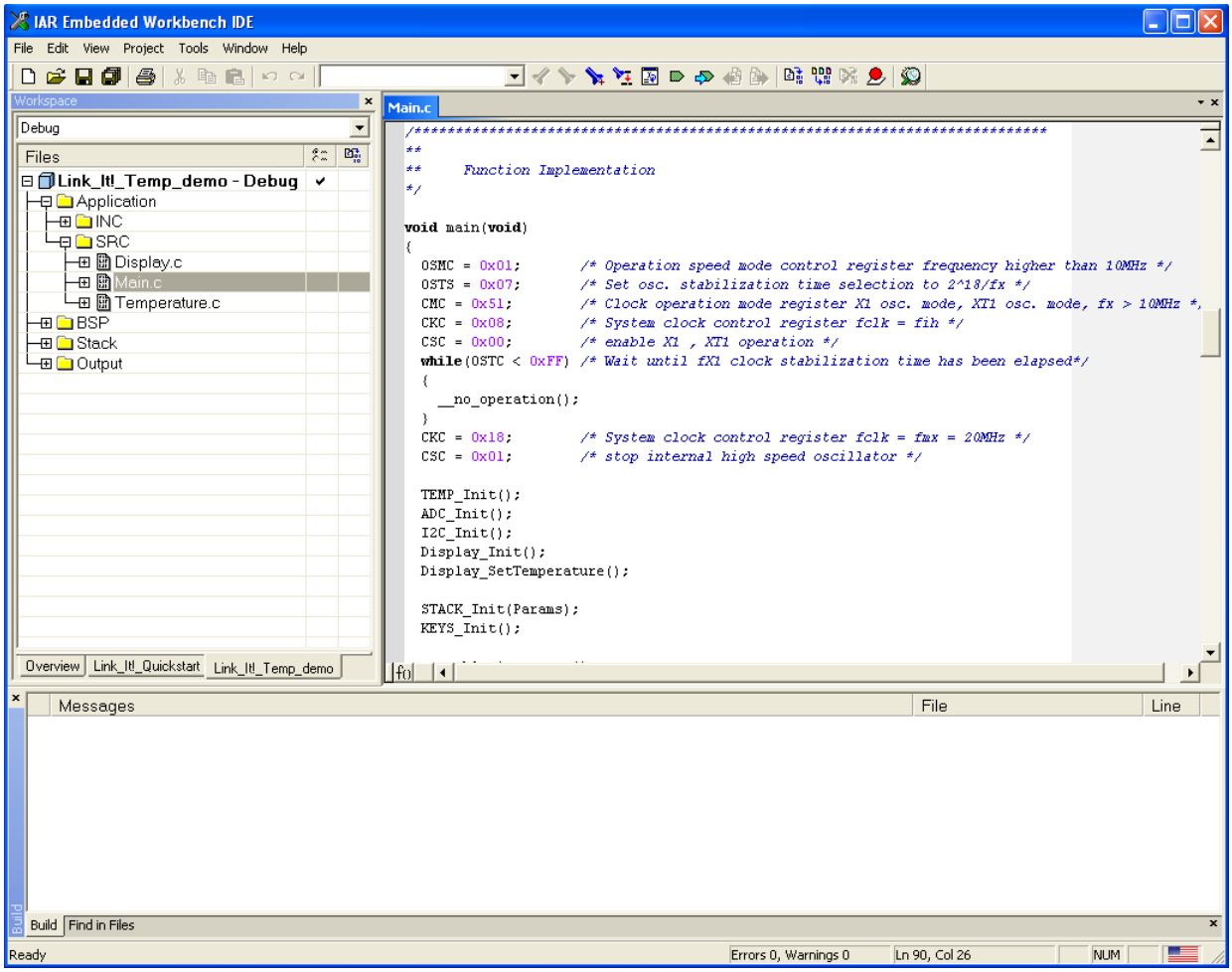


Figure 11-3. IAR Embedded Workbench Main IDE window

To verify that the right debugging device is chosen please open the project options window by clicking **Project →Options** and then open the tab **Debugger**.

Caution Although the On-board debug interface is used, the MINICUBE C-Spy driver must be selected instead of the standard driver TK-78K used for other starter kits. If the debug session via MINICUBE2 and the OCD1 connectors shall be started, also the MINICUBE C-Spy driver must be selected.

The corresponding COM port where the *78K0R-Link it!* board is connected to the host PC will be detected automatically by the IAR C-SPY debugger.

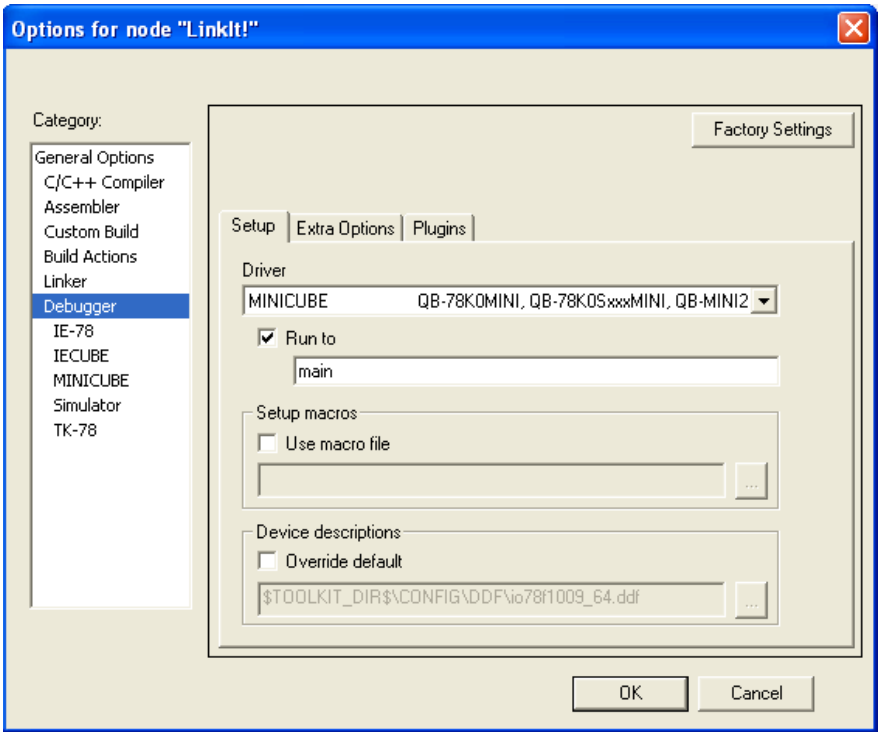


Figure 11-4. IAR Embedded Workbench Debugger Options

The next step is to check that the correct linker settings are set. This can be done in the “Linker” category as shown below. Select the “Config” tab and check that the linker command file “lnk78f1009_64.xcl” is selected. This file is used by the linker and contains information on where to place the different sections of code, data and constants that may be used within the demo project:

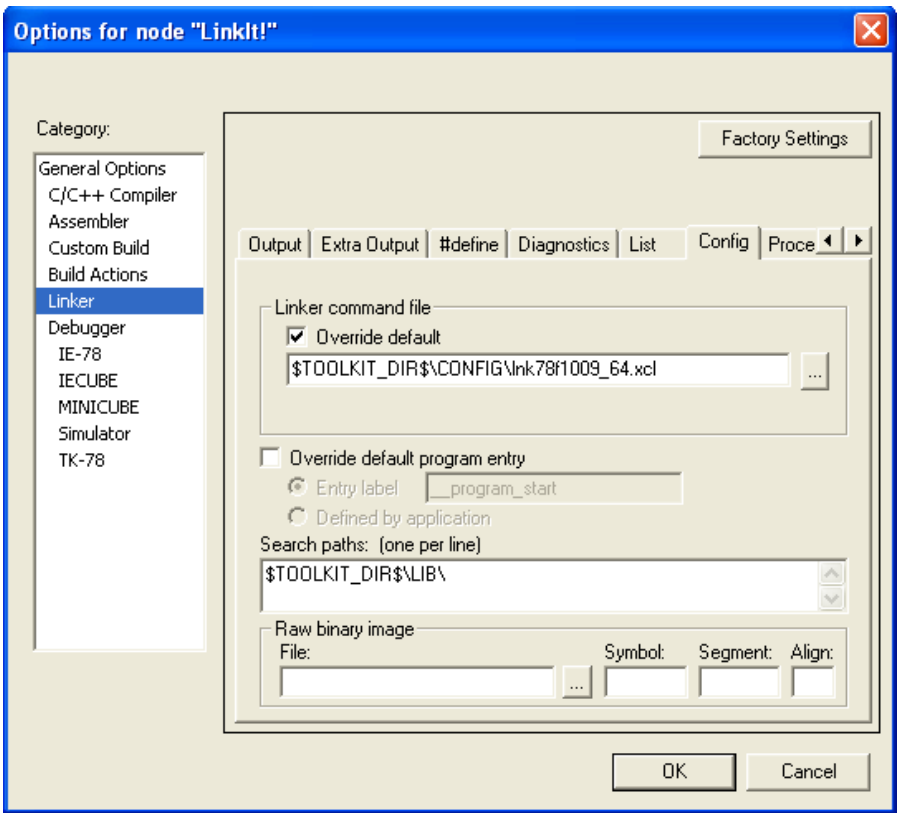


Figure 11-5. Embedded Workbench Linker Configuration

Now after everything has been setup correctly it's time to compile and link the demonstration project. Close the Options menu and select "Rebuild All" from the "Project" menu. If the project is compiled and linked without errors or warnings it can now be downloaded to the *78K0R-Link It!* board and debugged.

To start the IAR C-SPY debugger select the option "Debug" from the "Project" menu or press the "Debugger" button.

When first starting the debugger connection, after building the project, it is necessary to set up the right connection settings. Please take care that the following settings are chosen:

ID code = FFFFFFFFFFFFFFFFFFFF

Main clock = External 18.432 MHz

Sub clock = External 32.768 KHz

Target connect = TOOL0+TOOL1

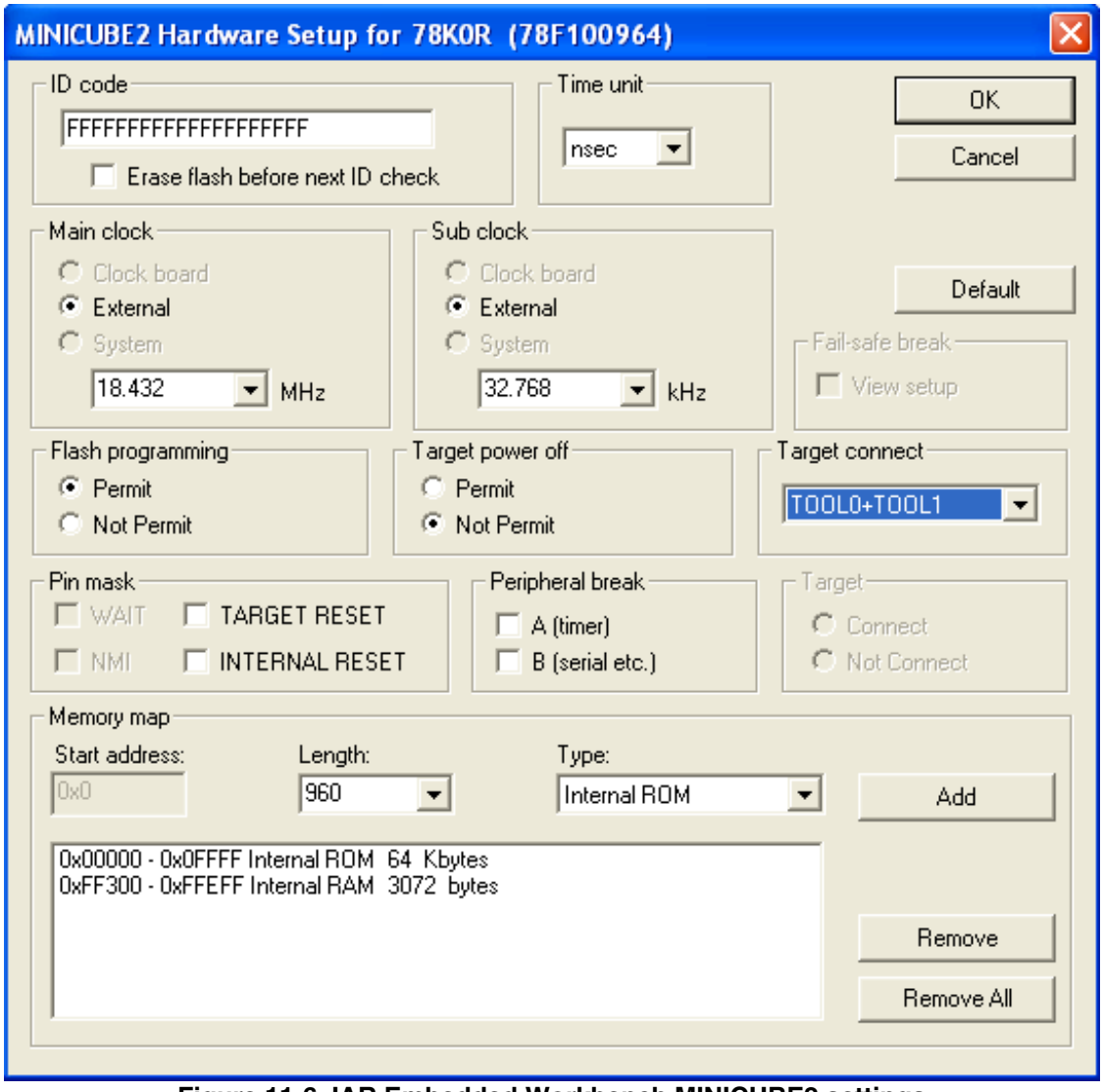


Figure 11-6. IAR Embedded Workbench MINICUBE2 settings

Now the debugger is started and the demo project is downloaded to the *78K0R-Link It! board*. The progress of downloading is indicated by blue dots in the MINICUBE Emulator window. Please note that downloading of larger executables may take some time.

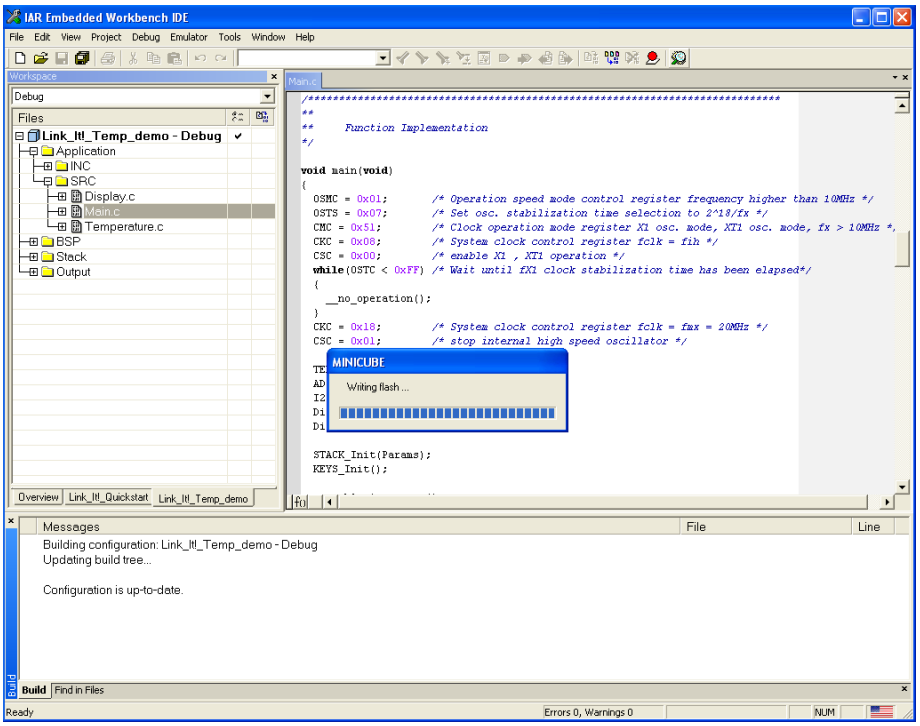


Figure 11-7. IAR project download

After the download was completed all debug features of IAR C-SPY debugger are available, i.e. Single Stepping, Step Over/-In/-Out, Go-Execution, Breakpoints, Register / Memory view etc.

To get more details on the debugger configuration and capabilities please refer to the “78K IAR Embedded Workbench IDE User Guide” of the IAR installation.

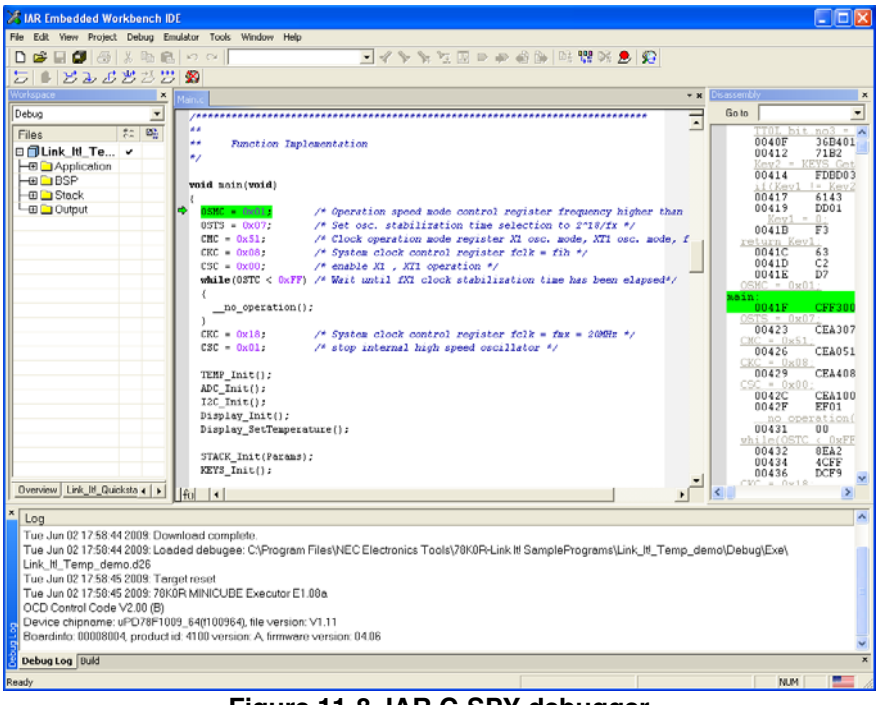

IAR Embedded Workbench IDE
Log
Tue Jun 02 17:58:44 2009: Download complete.
Tue Jun 02 17:58:45 2009: Target reset
Tue Jun 02 17:58:45 2009: 78K0R MINICUBE Executor E1.00a

Figure 11-8. IAR C-SPY debugger

CHAPTER 12 IO-LINK TEMPERATURE SENSOR SAMPLE

The demo application shows the IO-link communication protocol as well as different features present on the board such as the display (Teach-In), the Sensor (Temperature), the TMG Stack, the Elmos physical layer, analog digital conversion and more.

The *78K0R–Link It!* board is shipped with the demo preprogrammed to the microcontroller. When the board is connected to an IO-Link Master and communication is established, the temperature is measured and transmitted through IO-Link.

For the purpose of this demo the TMG USB IO-Link Master has been used. The screenshots in the following section are those of the TMG device tool software, operating with the TMG master device.

If you have the TMG Master device, a XML device description file for the *78k0R-Link-It!* board demo can be found on the *78K0R–Link It!* CD-ROM in the "`\Link-it XML Device Description file`" folder. For more details on installing the XML Device Description file, please refer to section **8.6 XML Device Description file installation .**

Once the Device tools software has been updated, the *78K0R-Link it!* board can be controlled from the software GUI. For further details please refer to **section 12.2 Using *78K0R-Link It!* Board demo with TMG IO-Link Device Tool.**

Connect the IO-Link Master to the host computer. The *78K0R-Link-It!* board should be now connected to the Master via the M12 cable see Figure 2-1. IO-Link system configuration

Remark **If you do not have the TMG USB IO-Link master, and your equipment does not support the XML description file, please refer to the "QuickStart Guide IO-Link Device Stack library" available on the CD-ROM for a list of indexes referring to the application's process-data and parameters accessible trough IO-Link.**

Caution **jumpers and switches on the *78K0R-Link-It!* board must be set to their factory settings as described in section 7.1. *78K0R–Link It!* Factory jumpers and switches Settings**

12.1 Demo Features

Once IO-Link communication is established with the Master, the board displays the current room temperature in 0,5 °C variation steps as per Figure 12-1.

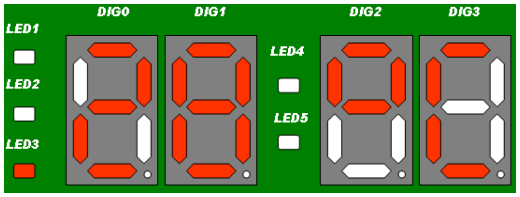


Figure 12-1. *78K0R–Link It!* Demo display

The current measured temperature value is displayed with 2 digits (DIG0 and DIG1).

The decimal point behind the last digit is the 0.5°C indicator (for 28.5 °C it would be lit).

The user can set two (Upper/Lower) thresholds, set by default to 32°C, 29°C respectively, when the board is connected.

LED1 to LED3 are alarm LEDs representing thresholds set by the user.

LED1 lights up when the measured temperature is above the Upper Threshold

LED2 lights up when the measured temperature is between the two Thresholds

LED3 lights up when the measured temperature is below the Lower Threshold

12.1.1 Min/Max Temperature display

The minimum/maximum temperatures measured since the sensor has been connected to the IO-Link master can be readout on the display at any time when pressing SW2 (lo: xx) for the Min Temperature, and SW3 (hi: xx) for the Max Temperature. XX represent the temperature in degree Celsius.

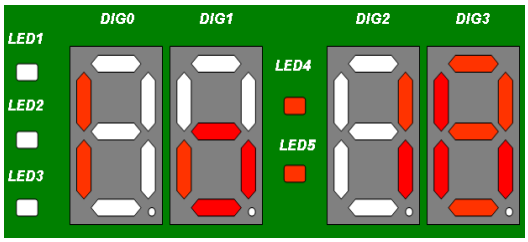


Figure 12-2. Minimum Temperature Readout

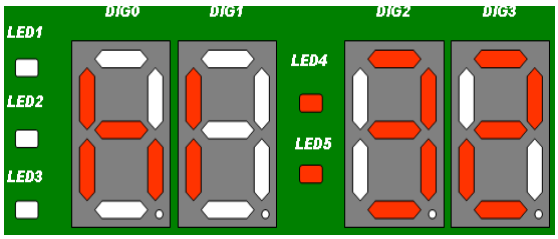


Figure 12-3. Maximum Temperature Readout

12.1.2 Temperature thresholds setting

The user has the ability to set two thresholds (a Lower and an Upper threshold).

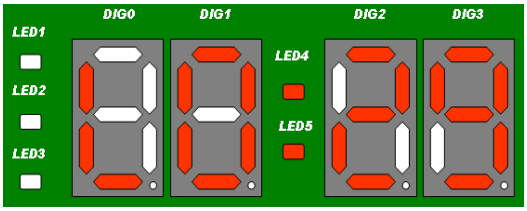


Figure 12-4. Default Lower Threshold

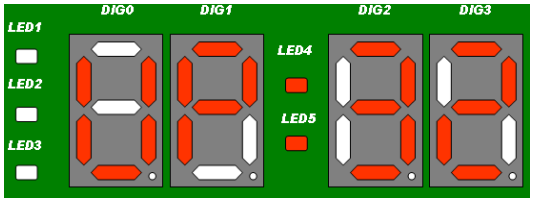


Figure 12-5. Default Upper Threshold

1. To enter the settings menu, press the Center button on SW4. The display thereafter shows the current value of the lower threshold (for example LO: 29 default).

   Pushing the SW4 button to the right increments the lower threshold in 0,5 °C steps

   Pushing the SW4 button to left decrements the lower threshold in 0,5 °C steps

   Pushing the SW4 button up, increments the upper threshold it in 0,5 °C steps

   Pushing the SW4 button down decrements the upper threshold in 0,5 °C steps

   The upper threshold can never be lower or equal to the lower threshold and vice-versa.

   The actual set threshold temperature as well as the min/max value, are displayed with 2 digits only. The point behind the last digit is the 0.5 indicator (therefore for 32.5 °C it would be lit).

2. To confirm the settings, press the center button on SW4 again. The display thereafter, reverts to the current measured temperature display.

All of the temperature values, thresholds values and settings can also be changed or read using the TMG USB IO-LINK Master device tool.

12.2 Using *78K0R-Link It!* Board demo with TMG IO-Link Device Tool.

The IO-Link device tool can be used for the configuration of IO-Link masters, setting and steering parameters as well as the diagnosis of IO-Link devices.

IO-Link master initiates the communication, and channels information from the board to the host machine. The operator is able to see the information on the host machine via the installed IO-Link Device Tool.

12.2.1 Getting started with the TMG master:

1. Launch the IO-Link device Tool.
2. Once the tool is up and running, two panes can be seen in the GUI (Topology on the left, and Catalog on the right),see Figure 12-6

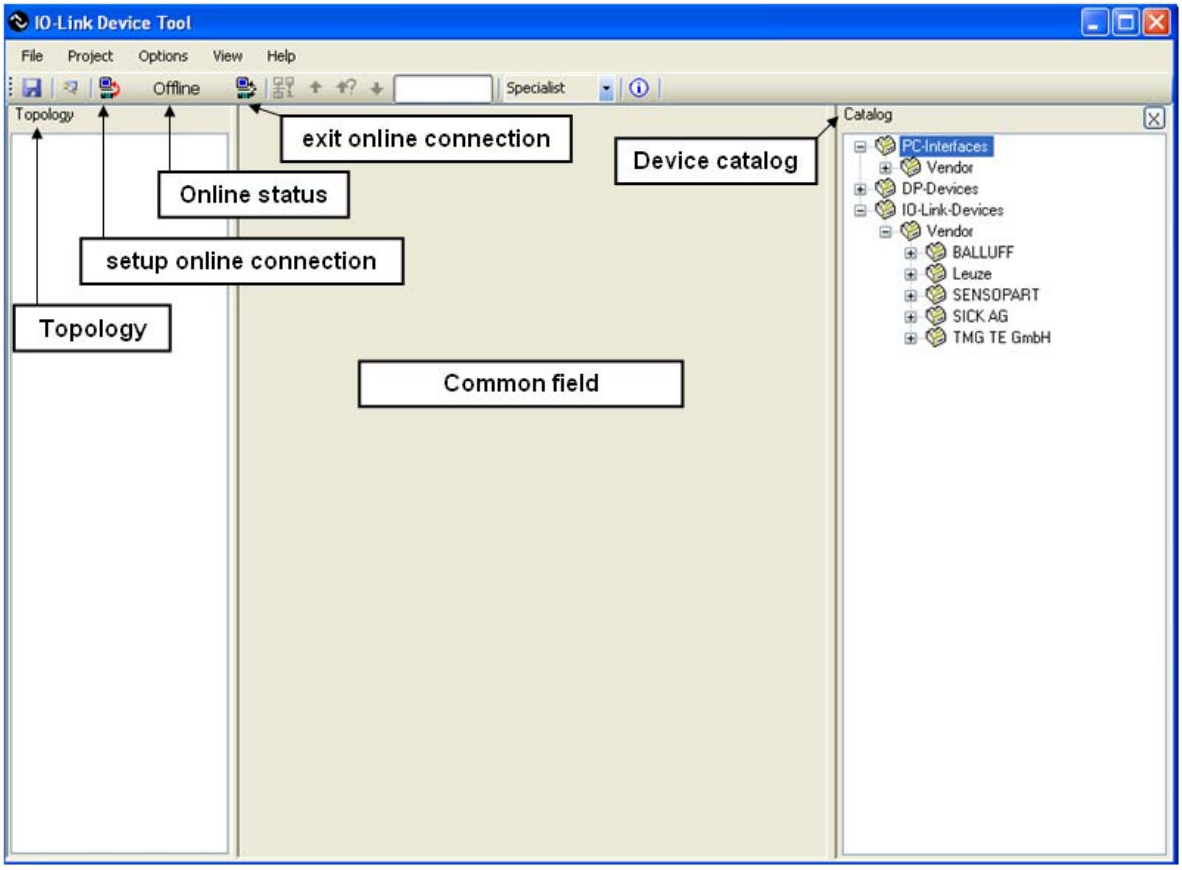


Figure 12-6. IO-Link Device Tool GUI

The topology pane shows the topology from the PC interfaces to the IO-Link Devices

The Catalog pane shows all the Devices installed with the tool.

On the symbol bar, two icons (setup/exit online connection) allow to set the IO-Link line status.

When the line is Online, the “Online status” symbol will blink green with the symbol “online”

The common field is currently blank but it will display the description of the devices present in the Topology view

12.2.2 Updating the IO-Link Device catalog

Before the *78K0R–Link It!* can be displayed in the device tool, the IO-Link devices catalog must be updated

1. In the Catalog pane, right click on “IO-Link Devices” and select [Actuate catalog]

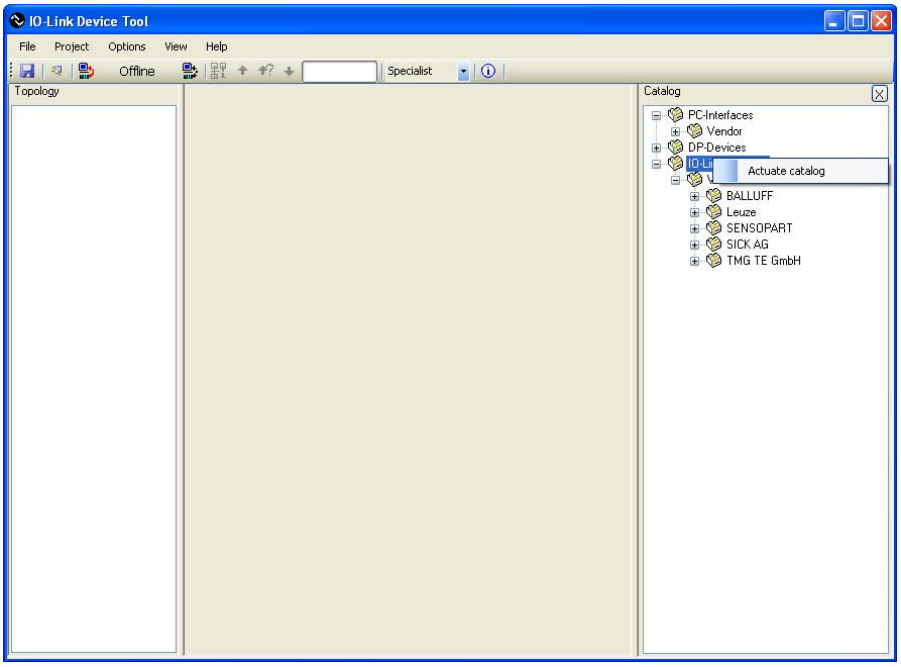


Figure 12-7. Catalog update

2. Press [Yes] in the small window with the message [Do you want to insert the 78K0R–Link It! Temperature sensor of NEC Electronics (Europe) into the catalog]

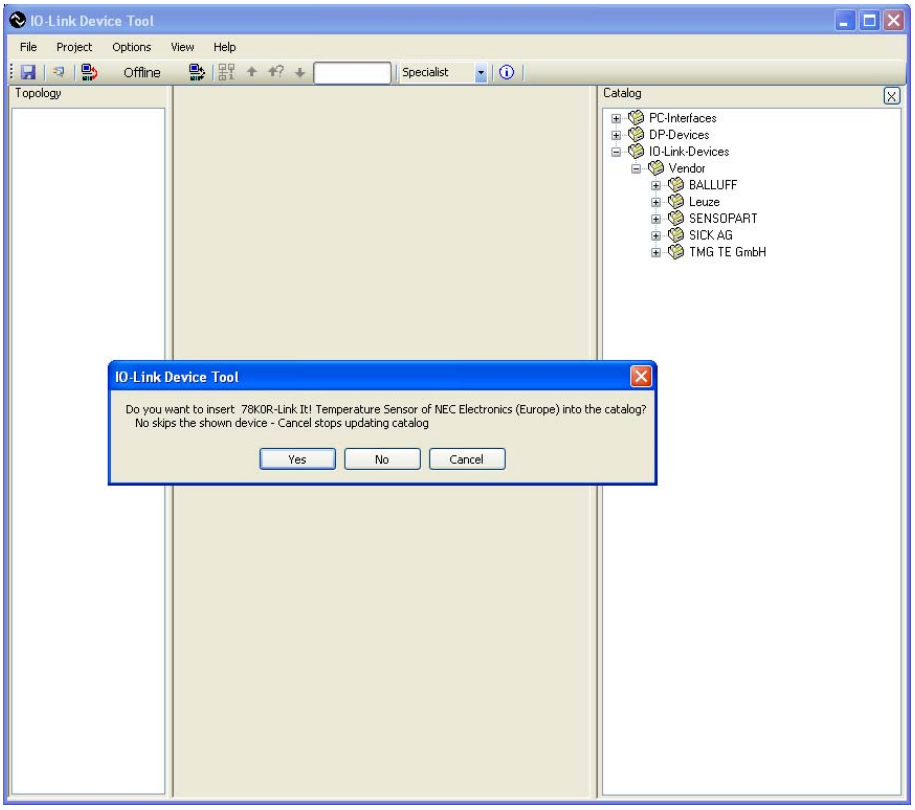
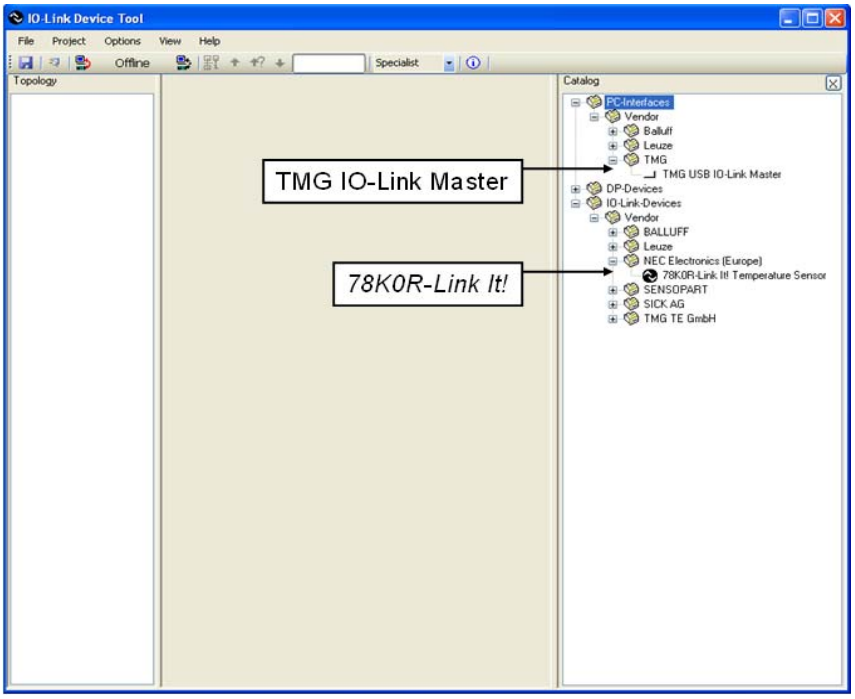


Figure 12-8. Catalog update confirmation

12.2.3 Catalog update confirmation

A successful update will show the NEC Electronics (Europe) vendor and the *78K0R–Link It!* Temperature sensor, in the IO-Link Devices section of the catalog.



The TMG USB IO-Link master can also be seen under PC Interfaces section of the catalog.

Figure 12-9. *78K0R–Link It!* I Device catalog

12.2.4 IO-Link communication set-up

1. From the Catalog pane, drag and drop the TMG USB IO-Link Master into the Topology pane.
2. Left click on TMG USB IO-Link Master DE in the Topology pane, and the IO-Link Master's details can be seen in the Common pane (centre section of the window).

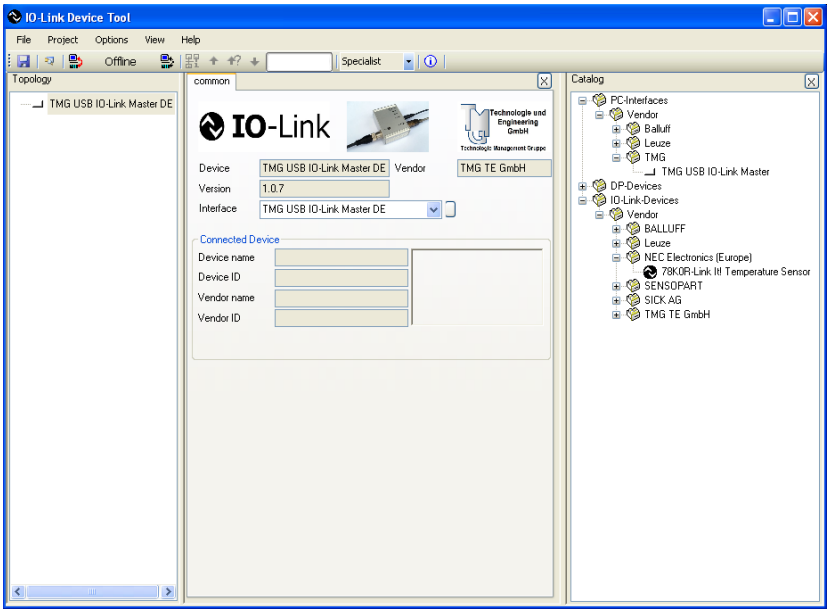


Figure 12-10. TMG USB IO-Link Master

3. Left click on the "Setup online connection" icon in the Device Tool GUI, will show the "Check Config" button under "Connected Device" in the Common section.

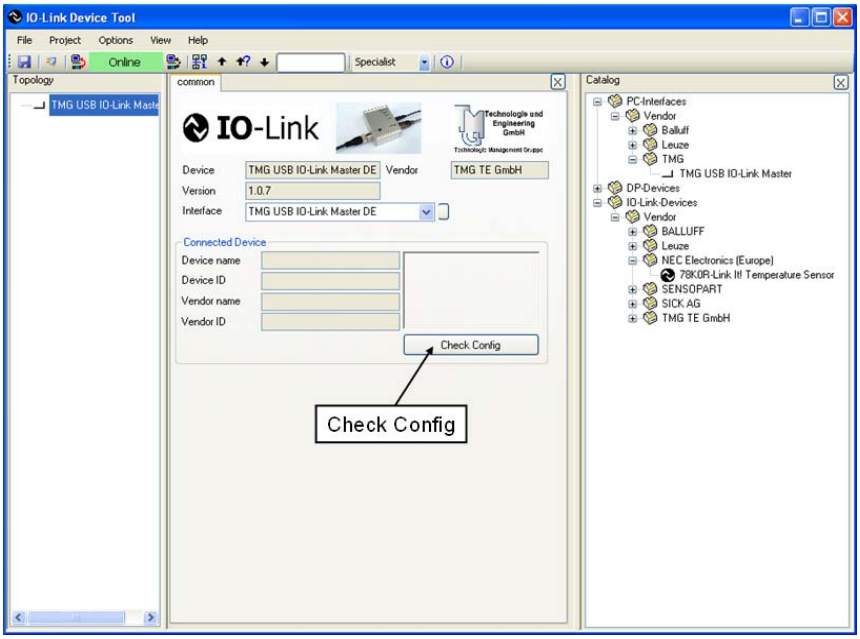


Figure 12-11. Online status, Check Config

4. Click on the "Check Config" button.

   The LEDs on the Master will blink as the master tries to connect to the *78K0R–Link It!* board

   If the *78K0R–Link It!* board is working and the master can connect to it, a small window will show with information on the board and a “Take over type of device into engineering” button. See **Figure 12-12. Check Config successful**

   If the master cannot connect to the *78K0R–Link It!* board a window with an error message “can’t read configuration” will appear. See **Figure 12-13. Check Config failure**.

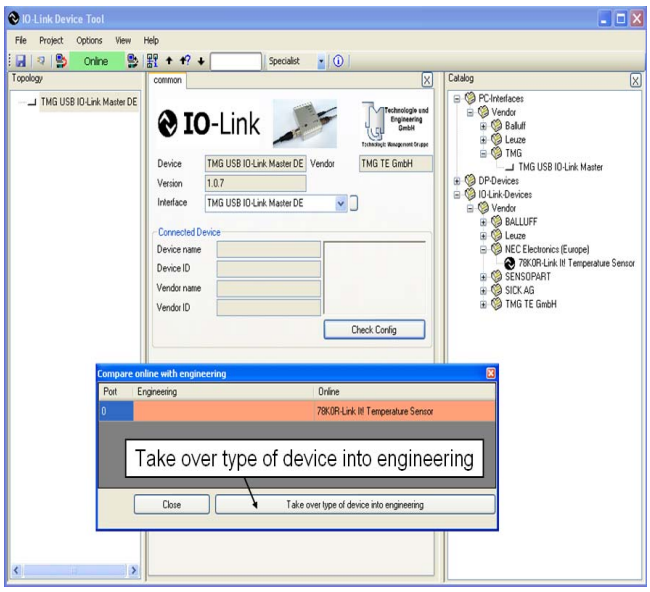


Figure 12-12. Check Config successful

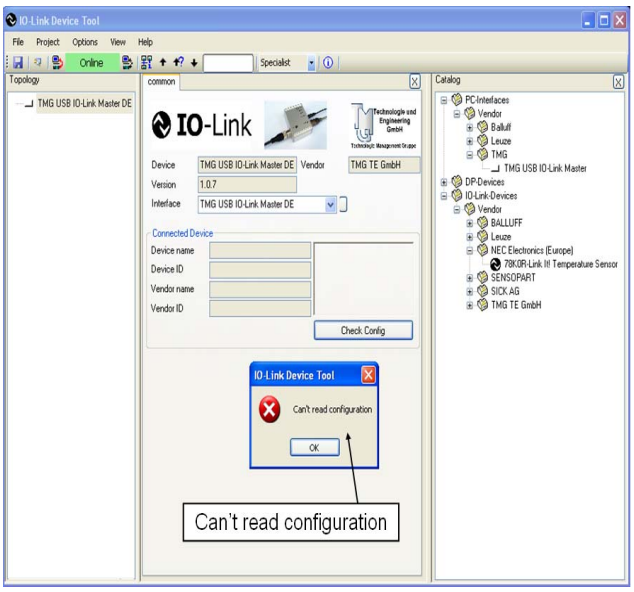


Figure 12-13. Check Config failure

Caution **It can happen sometime that the "can't read configuration" message appears in the Device Tool when the Master is not properly initialized. Unplugging the master from the USB port of the host machine and re-starting the Device tool solves this problem. Also please check the board settings are properly set for IO-link communication and that the board is properly connected to the IO-Link master.**

5. Click on the "Take over type of device into engineering" button

   The *78K0R–Link It!* board will now appear under the TMG USB IO-Link Master DE in the topology pane, and details on the board can be read in the Common pane

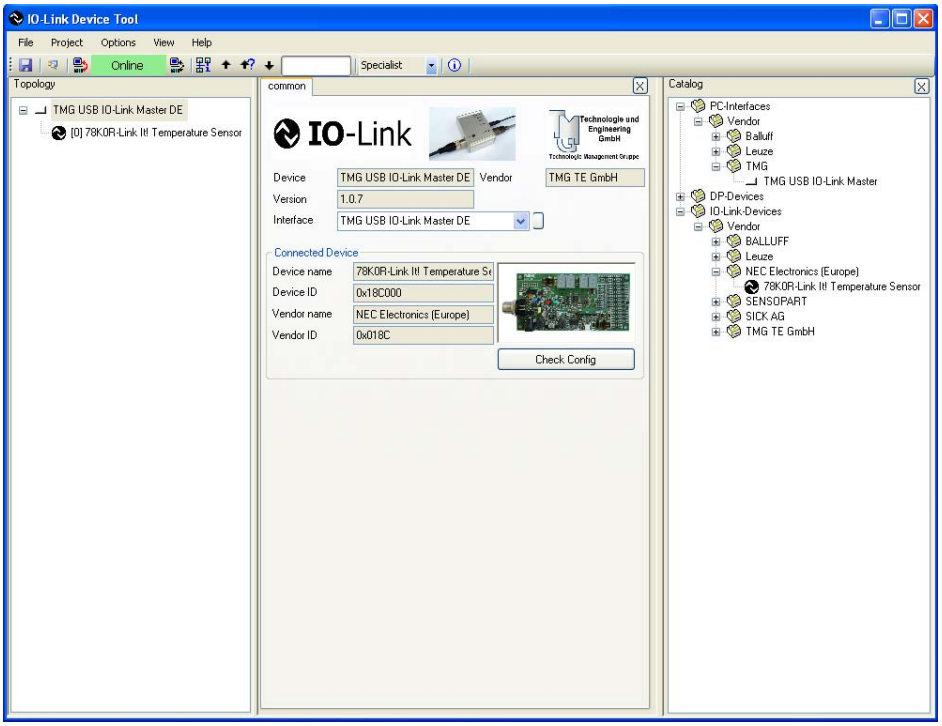


Figure 12-14. IO-Link communication active

The IO-Link communication is now active and we can have a closer look at the device and the sensor application running on the board

The Common pane provides information on the connected device such as:

Device name: 78K0R-Link It! Temperature Sensor

Device ID: 0x18C000

Vendor name: NEC Electronics (Europe)

Vendor ID: 0x018C

Picture of the Io-Link device connected to the master

12.2.5 *78K0R-Link It!* Board sensor demo in IO-Link device tool

In this section we see how the *78K0R–Link It!* Board works with the IO-Link Master and how the demo's features explained earlier can be used from the IO-Link Device tool GUI.

Left click on the *78K0R–Link It!* in the topology pane to display generic information on the board in the Common pane.

Next to the Common tab, two other tabs can be seen (Process data and Parameter)

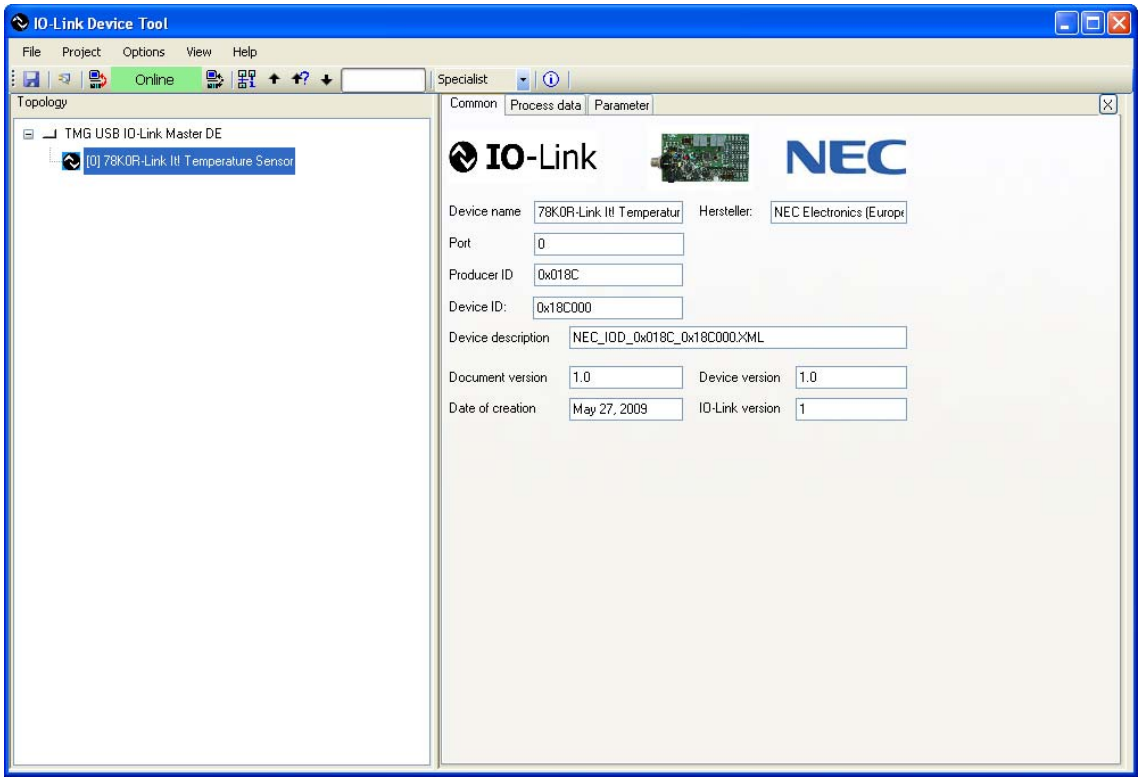


Figure 12-15. *78K0R–Link It! in device tool*

12.2.5.1 Common tab

The Common pane provides information on the device such as:

Picture of the device

Device name, Product ID, Device ID, vendor name

Port used on the master. Here the kit is connected to port 0.

Device description file, its version and date of creation.

Device version

IO-Link version.

12.2.5.2 Process data tab

The Process data tab displays the sensor measurements (process data inputs from the sensor).

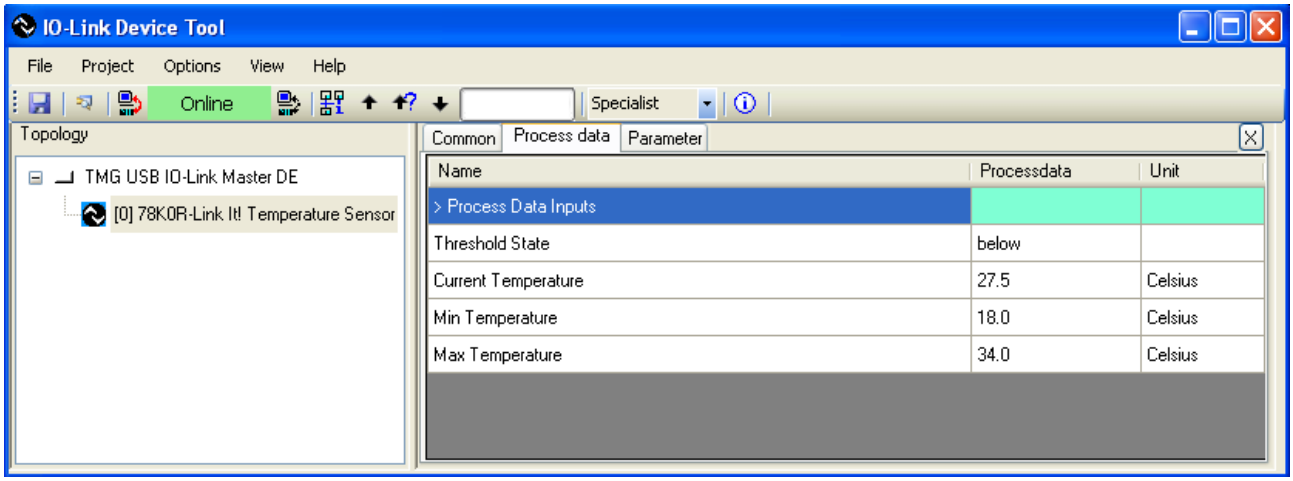


Figure 12-16. *78K0R–Link It!* Process data

The user can find information such as the Min/Max Temperature values, the Current Temperature, and the Threshold State (above, between, and below, representing LED1, LED2, and LED3 respectively).

12.2.5.3 Parameter tab

The Parameter tab displays the default settings of the sensor, but also enables the user to teach the sensor by writing new thresholds values to the board.

From the tabs on the parameter page we can find general read only vendor specific parameters such as:

Vendor and product names

Hardware, firmware revisions

From the tabs on the parameter page we can find read/write device specific parameters such as:

Upper/Lower Thresholds

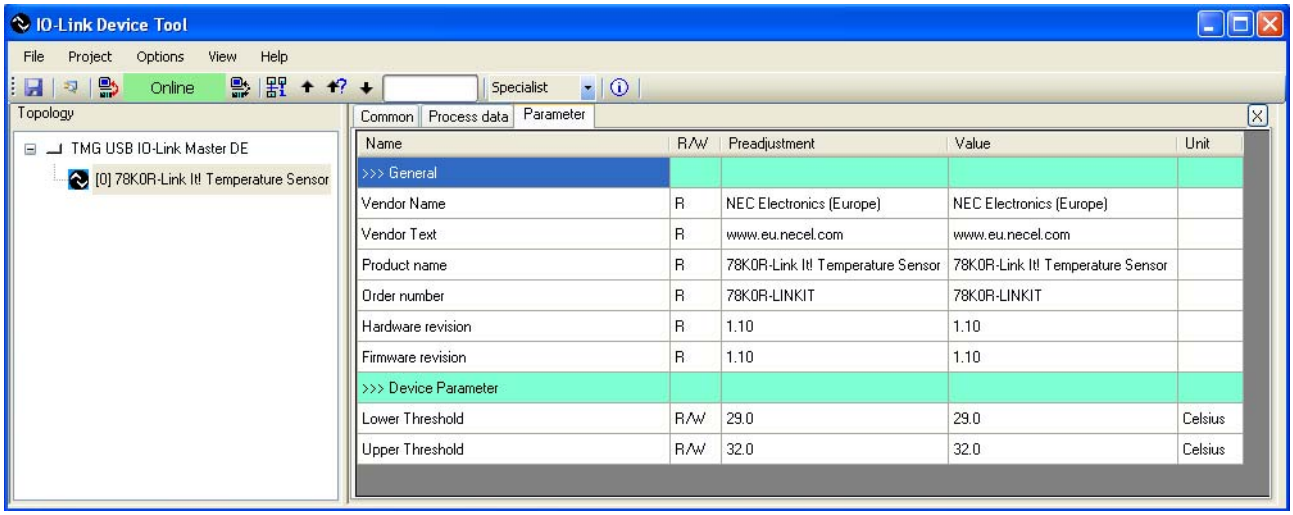


Figure 12-17. *78K0R–Link It!* Parameter page

12.2.6 *78K0R-Link It!* Board sensor Teach-in

When the user opens the parameter page for the first time, the device specific parameters are set to their default values.

The “Pre-adjustment” and “Value” columns match each other in the parameter page, see **Figure 12-17. *78K0R–Link It!* Parameter page**

The “Pre-adjustment” column displays the default sensor settings

The “Value” column displays the current sensor settings

12.2.6.1 Read parameter from the *78K0R-Link It!* Board sensor

To read or refresh the display of the current parameter setting from the board:

1. Under the “Value” column, click Left in the cell corresponding to the parameter you want to read.

   The cell is highlighted in blue and the current parameter value is displayed

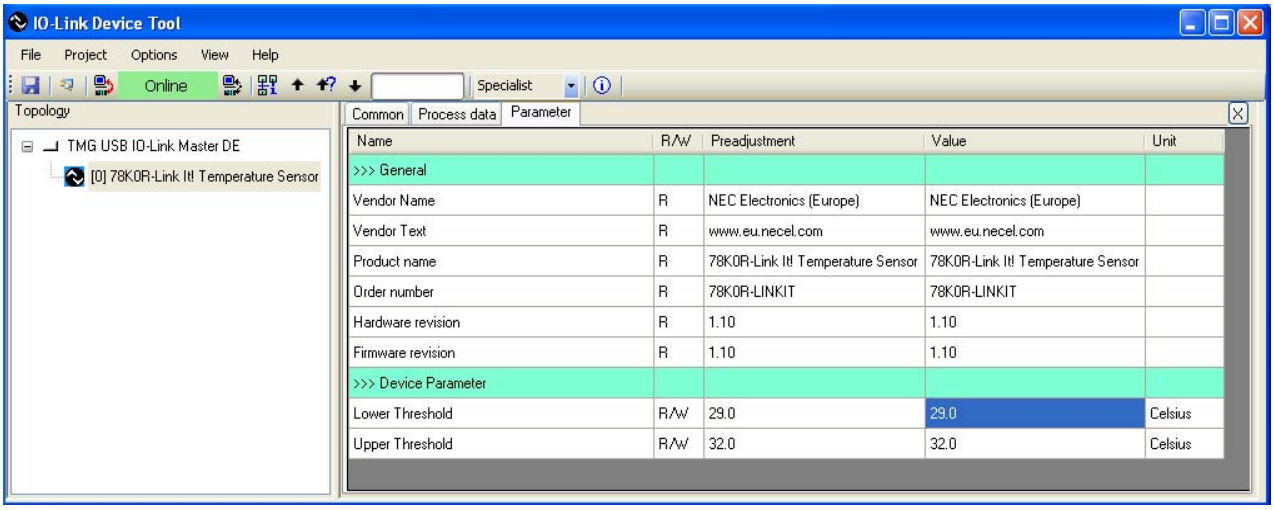


Figure 12-18 shows the reading of the lower temperature threshold of 29°C set on the board

Figure 12-18. Lower Threshold value reading

The same procedure is used to read the Upper threshold set on the board

12.2.6.2 Write parameter to the *78K0R-Link It!* Board sensor

The teach-in functionality allows changing the valid temperature range on the fly by modifying the Upper/Lower thresholds

To write or teach a parameter to the board:

1. Under the “Value” column, click Right in the cell corresponding to the parameter you want to change.

   The cell is highlighted in blue and a dialog box will open to enter the new value

2. Enter a new value in the box and press the [Enter] key on your keyboard.

The new parameter is now passed to the board. You can check with the SW4 joystick that the parameter has been passed correctly to the board.

The Thresholds LEDs will automatically display what the current measured temperature is with regards to the new range.

Figure 12-19 shows the dialog box and the setting of the Lower threshold to 25°C.

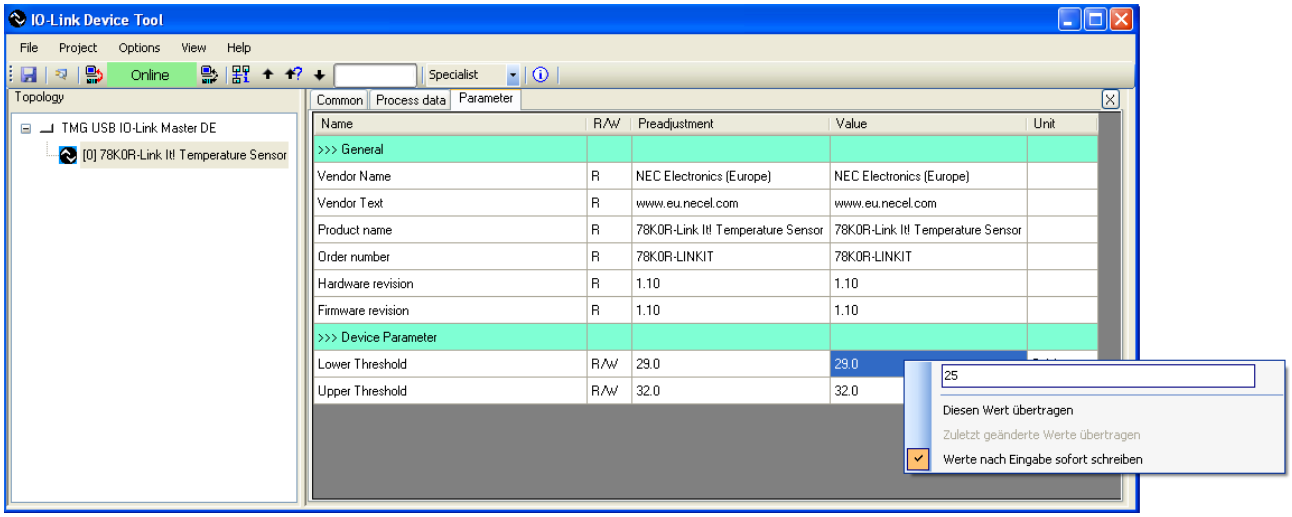


Figure 12-19. *78K0R- -Link It!* Thresholds setting

CHAPTER 13 CABLES

13.1 USB interface cable (Mini-B type)

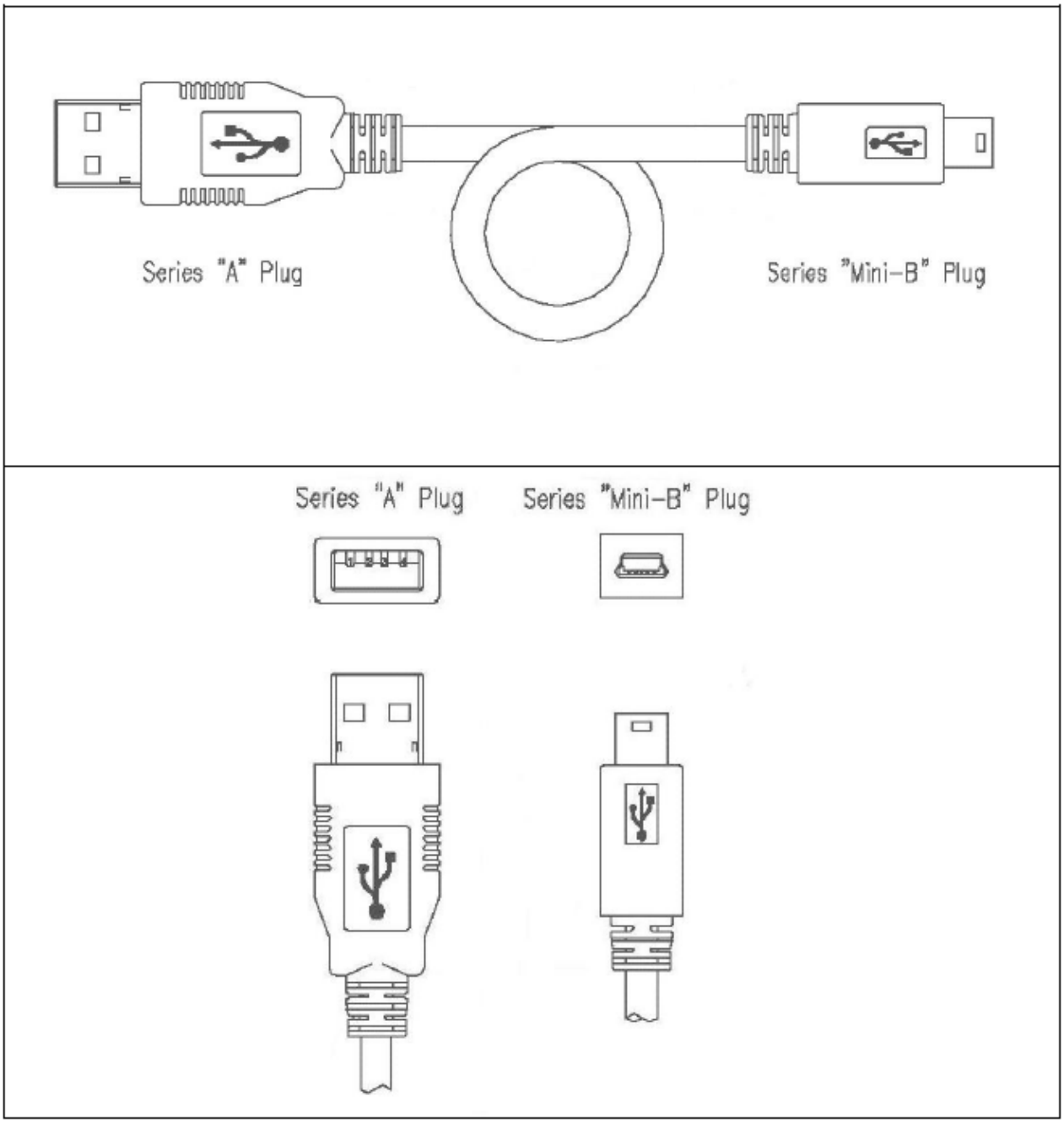


Figure 13-1. USB interface cable (Mini-B type)

CHAPTER 14 SCHEMATICS

Schematics descriptions for the *78K0R-Link It!* board. are attached to this document.
Use the *Attachments* tab for access (lower left side of the screen).

[MEMO]